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UNIFIED NETWORK/TRAFFIC TRANSMISSION MEDIA CONTROL

Prepared for
DEFENSE COMMUNICATIONS AGENCY
DEFENSE COMMUNICATIONS ENGINEERING CENTER
1860 Wiehle Avenue
Reston, Virginia 22090

Under
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AUGUST 1977

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER DCA 100-76-C-0082	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Unified Network/Traffic Transmission Control		5. TYPE OF REPORT & PERIOD COVERED Final
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s)		8. CONTRACT OR GRANT NUMBER(s) DCA 100-76-C-0082
9. PERFORMING ORGANIZATION NAME AND ADDRESS Computer Sciences Corporation 6565 Arlington Blvd. Falls Church, VA 22046		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS PE 33126K
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE Aug 77
		13. NUMBER OF PAGES 445
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) Same as 11		15. SECURITY CLASS. (of this report)
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

Same as 16

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

system control

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This task encompasses an analysis of the present overseas Defense Communications System (DCS) transmission media, network and traffic control methods and procedures and development of recommended unified system control mechanism for the near-term overseas DCS. The analysis addresses the existing transmission systems, AUTOVON, AUTODIN (I), AUTOSEVOCOM (I), and special circuits which restricts this study to the current complement of DCS equipment in the field. Planned systems, such as AUTODIN (II), AUTOSEVOCOM (II), and planned control

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improvements, such as RTAC for DSCS, are subjects for future study. The effort encompasses developing a unified system control configuration responsive to the needs/requirements of the various control levels of the DCS, identification of the functions to be performed at each level, and the hardware/software capability required in support of these functions.

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SECTION 1 - INTRODUCTION

1.1 GENERAL

This report is a presentation of a system study and outlines a recommended approach to an operational unified system control mechanism for the near-term overseas Defense Communications System (DCS). An interim report dated April 1977 described in general terms the recommended approach together with detailed functional flow diagrams showing the information gathering, processing and flow required for implementation. This final report includes a summary of the interim report together with a detailed description of the functional requirements, data base requirements, software and hardware considerations including sizing and loading for each level of the system control hierarchy. Also included are recommended figures of merit (FOMs) for assessing the performance of the overseas DCS.

1.2 PURPOSE

The prime reason for implementing a system of the type described herein is to improve the operational effectiveness of the DCS and each DCS system control level by integrating the transmission and switched network controls and provide a nucleus for the integration and interfacing of ongoing programs associated with system, subsystem and network control.

1.3 SCOPE

The scope of this task encompasses an analysis of the present overseas DCS transmission media, network and traffic control methods and procedures and development of a recommended unified system control mechanism for the near-term overseas DCS. The analysis addresses the existing transmission systems, AUTOVON, AUTODIN (I), AUTOSEVOCOM (I), and special circuits which restricts this study to the current complement of DCS equipment in the field. Planned systems, such as AUTODIN (II), AUTOSEVOCOM (II), and planned control improvements, such as RTAC for DSCS, are subjects for future study. The effort encompasses developing a

unified system control configuration responsive to the needs/requirements of the various control levels of the DCS, identification of the functions to be performed at each level, and the hardware/software capability required in support of these functions.

1.4 APPROACH TO THE TASK

1.4.1 Approach

The initial effort was directed toward identification and analysis of the near-term overseas DCS system control structure and includes transmission media and switched networks. The intention was to identify specific sources for the collection and correlation of data required for system control and network traffic management.

The results of this initial effort were used to develop a unified system control configuration. This effort included the identification of the general information flow requirements and controls to be exercised at each control level together with the required interface and interplay among switched networks and transmission media. Functional flow diagrams were then developed in support of the unified system control configuration to show the information gathering, processing and flow required.

These functional flow diagrams and the supporting documentation were presented in a report titled "Unified Network/Traffic Transmission Media Control (Interim Report)" dated April 1977 which forms the baseline for the remainder of the program.

Having identified a unified system control configuration and the functions required to be exercised at each level of the DCS control structure, the next step concerned the hardware and software capabilities required to support the identified configuration.

Four levels where processing capability is required were identified. These are the ACOC, the Sector, the Node and the AUTOVON Switch. A data base structure was developed for each level to satisfy the data storage requirements in support of

the functions identified in the functional flowcharts. Every effort was made to ensure that the data base structure was similar to that envisioned for the ATEC system, especially since the connectivity directory data is very similar to that required by ATEC; thus keeping open the possibility of shared or common data bases.

Next a preliminary software design was performed in order to size the software system and a sizing analysis for each level of the unified system control was performed. Finally, hardware and software costing estimates were developed for each level together with a total hardware/software estimated for the European theater.

The methodology employed, and assumptions made in developing the unified system control mechanism are presented with their respective work elements in the appropriate sections of this report, and need not be repeated here. However, because of the relative complexity and magnitude of the software sizing work element, a detailed software sizing methodology is presented in the following paragraph. This is intended to familiarize the reader with the basic design concept and insure a fuller appreciation of the software sizing analysis sections.

1.4.2 Software Sizing Methodology

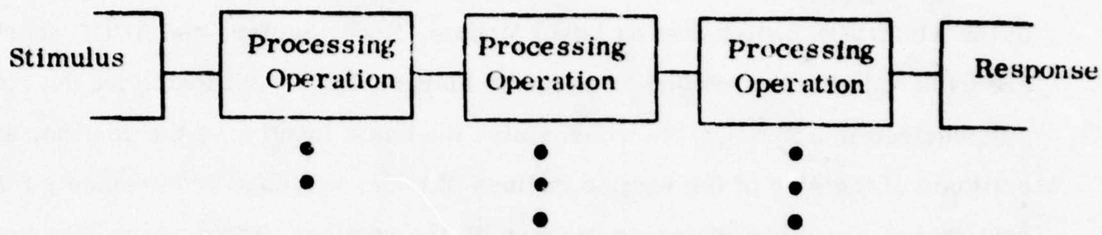
In the following sections of this report descriptions of suggested functional capabilities and preliminary software system designs supporting those capabilities are presented for each level of the unified control hierarchy. A preliminary software design is a necessary step in performing a sizing analysis of this magnitude. By performing this step, commonalities in functional software can be more easily recognized and considered in the overall sizing estimate.

The THREADS design methodology was employed in the design of the unified control system software. THREADS is a CSC-developed methodology and discipline for assisting system design, development, verification, testing, and management.

The initial step in the THREADS design process is the identification of a set of system level requirements. The system level requirements for each unified control element are considered as well as the requirements for the overall system. Using these requirements, a set of external system stimuli and system responses are defined. The stimuli serve to identify a set of external interfaces to each level of the unified control processing system including peripheral interfaces and real-time data sources (i.e., ATEC). The expected responses determine the processing that must be performed. The system level requirements, external stimuli and system responses define a set of system THREADS. Each THREAD identifies a unique stimulus processing response activity. For example, the receipt of communications channel input interrupt is a stimulus to the THREAD which controls the data transfer from the channel into the processor's memory. The processing in this THREAD involves interface handling and buffer control. The response to this THREAD is the received data residing in a specified portion of memory and necessary control operations for scheduling the data for additional processing. Figure 1-1 shows the standard schematic representation for a THREAD.

In addition to the stimulus-processing-response information, a THREAD includes a list of software modules used to implement each of its processing tasks. This provides a means of mapping system processing requirements to unique sets of software.

After addressing all external stimuli and related THREADS, a set of THREADS are identified which support internal system stimuli. For example, in the communications handling THREAD described earlier, one of the responses is the scheduling of data for subsequent processing. That response serves as a stimulus for a second THREAD which performs the processing. In this case, the stimulus is of an internal nature, generated by the software itself.



(a) Detailed Representation of a THREAD

(b) Abbreviated Representation of a THREAD

Figure 1-1. Schematic Representation of a THREAD

After the design progresses to the stage where a complete set of THREADS is defined, the THREADS are gathered into ordered sets. The sets may be hierarchically structured to show the relationships between groups of THREADS and the system elements or functions that they support. The THREADS contained in the software description sections of this report are presented in this manner so that the capabilities available to each unified control element are summarized by the THREAD hierarchies.

In order to size the software system, the routines identified during the design of the AUTOVON Switch Station Level Module, Node, Sector, and ACOC subsystems are gathered into four computer program hierarchies. Additionally, each routine is summarized in a sizing table which states the basic function of the routine, an estimate of the size of the routine in lines of code, and core requirements for the routine and significant data associated with the routine. The core requirement for each routine is based on an expansion ratio of 15 bytes of core for each line of HOL code. This ratio for a 16-bit word length minicomputer is derived from two components. First, it is assumed that the average HOL statement expands into 5 assembly level instructions. This expansion is commonly experienced when using moderately complex statements with currently available minicomputer compilers. Second, it is assumed that the average assembly level instruction requires 3 bytes of storage. This expansion is also commonly experienced since moderately optimized code consists of roughly one-half memory reference, one-half register-register or other single word operations. Typical memory referencing instructions require two words of storage. The combined effect of these two components is a 15 byte expansion ratio for each line of HOL.

Once the individual routine sizes are determined, the processor memory requirements can be determined by structuring the routines into overlay classes. The minimum processor memory requirement is reduced in this way since only the necessary software to perform a specific function is in core at any time. The use of overlays is addressed in the software sizing sectors since random access storage for on-line storage of the overlays is available at all levels of unified system control.

SECTION 2 - SYSTEM DESCRIPTION

2.1 GENERAL

This section presents a brief summary of the equipment configuration and information flow as presented in the interim report titled "Unified Network Traffic/ Transmission Media Control" and dated April 1977. In addition it contains an introduction to the detailed functional flowcharts which are presented in Sections 3, 4, and 5 of this report. Also included is a description of the man-machine interface and displays required in support of the System operation.

2.2 FUNCTIONAL INFORMATION FLOW

The functional information within the theater in support of the unified system control is shown in Figure 2-1. Functionally this flow agrees with the operations, maintenance and reporting philosophies already implemented and with the ATEC system operation as presently envisioned. The levels at which the information processing and control can be accomplished for both transmission systems and switched networks is indicated in this figure.

Switch transmission-related data is interfaced with purely transmission data at the node level and shares the same information flow to the sector and ACOC. Thus the same communications lines can be used for both. Switch network related data is required only at the switches and the ACOC. However this data can be forwarded through the nodes and sectors to the ACOC sharing the same communications lines as the switch transmission related data. Refer to the interim report dated April 1977 for details.

2.3 EQUIPMENT CONFIGURATION AND FUNCTIONS

The basic equipment configuration and functions required in support of the functional information flow are shown in Figure 2-2.

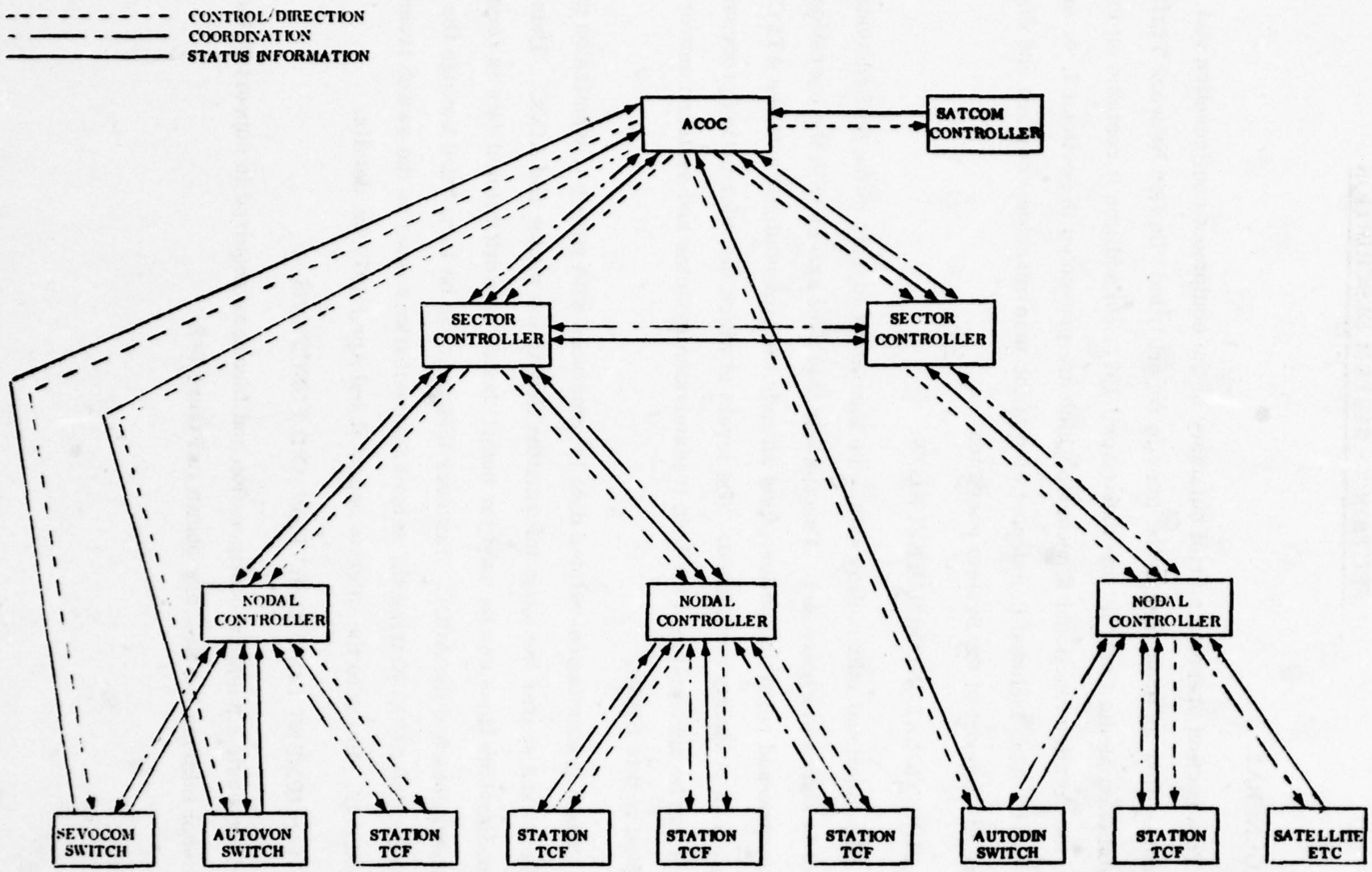


Figure 2-1. Combined Switched Network/Transmission System Functional Information Flow

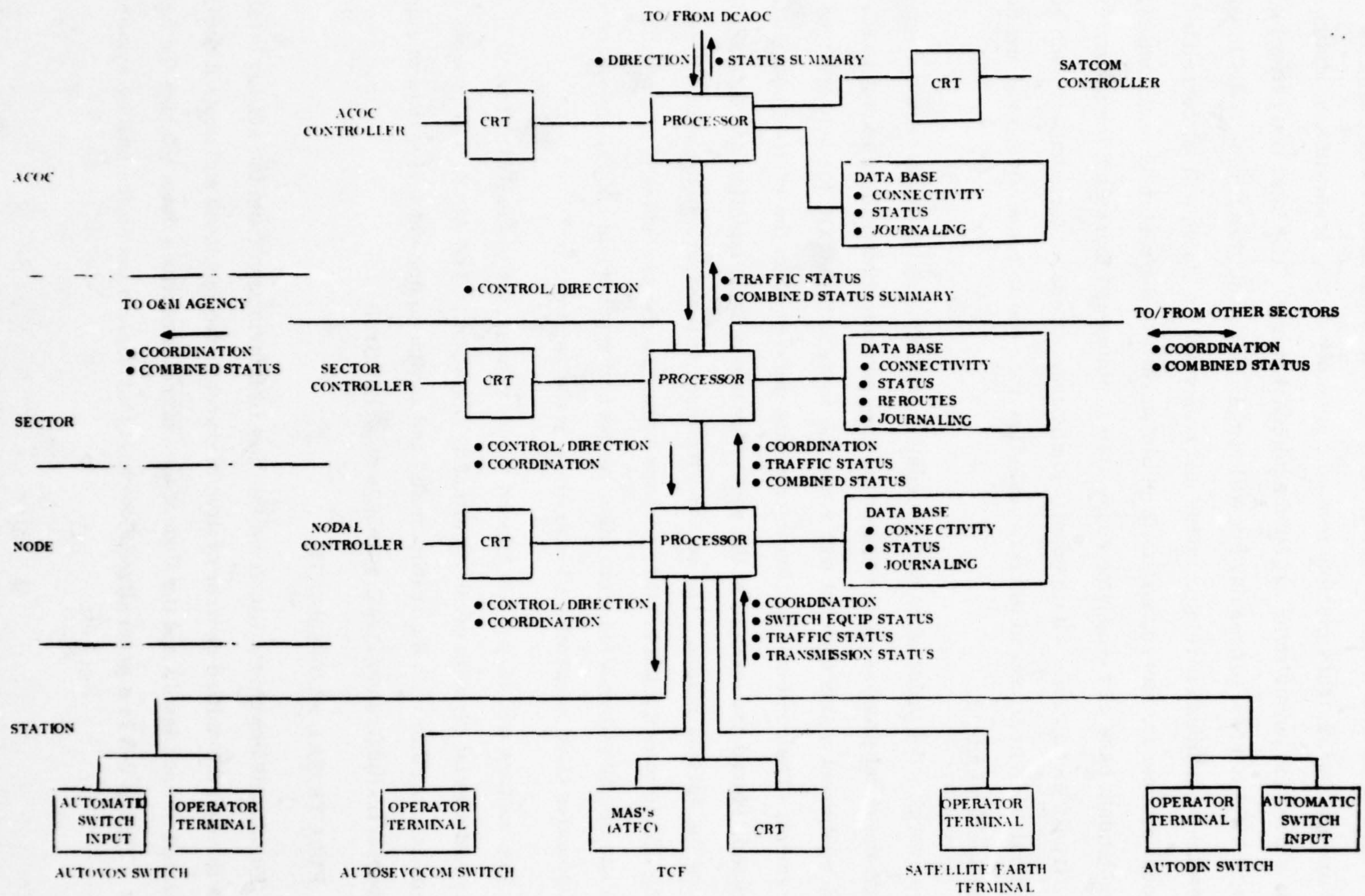


Figure 2-2. Unified System Control Equipment Configuration

Information flow from the station level 5 to the nodal level 4 will comprise coordination, switch transmission-related equipment status, transmission status, traffic status and purely switch related equipment status. The later two categories will not be subject to nodal processing but will simply be routed through the nodal level. The switch transmission-related status and transmission status will be correlated in the nodal processor, stored, updated, and forwarded to the sector as combined status. The nodal data base will comprise connectivity, status and journaling for all stations, links, trunks and circuits within nodal jurisdiction. Operator terminals at each station will permit station access to the node and allow the node to request, control and direct the station if required.

Several nodal processors will coordinate with and report to the sector processor. As with the nodal processor, the sector will not process the traffic status data nor the switch equipment status data but will route the same to the ACOC for network type assessment. The combined station information derived from the various nodes will be processed, stored and updated at the sector for use in fault isolation and determining the need for reroute action. The sector processor will determine the need for broadcasting update information to other sectors within the theater and will process and distribute update information from other sectors to appropriate nodes. Interface with the respective O&M agencies will take place at the sector.

The sectors will forward combined status summaries to the ACOC for all links, trunks and special circuits or as specified by the ACOC. The ACOC will process this information together with the traffic status and switch equipment status data in support of network/traffic/transmission assessment and control.

2.4 FUNCTIONAL FLOWCHARTS

Functional flowcharts illustrate the flow of information from the station level inputs through the unified control system hierarchy, the functions and control decisions performed at each level, and the flow of the control directives down through the hierarchy. Figure 2-3 is a generalized flowchart that depicts the entire unified system

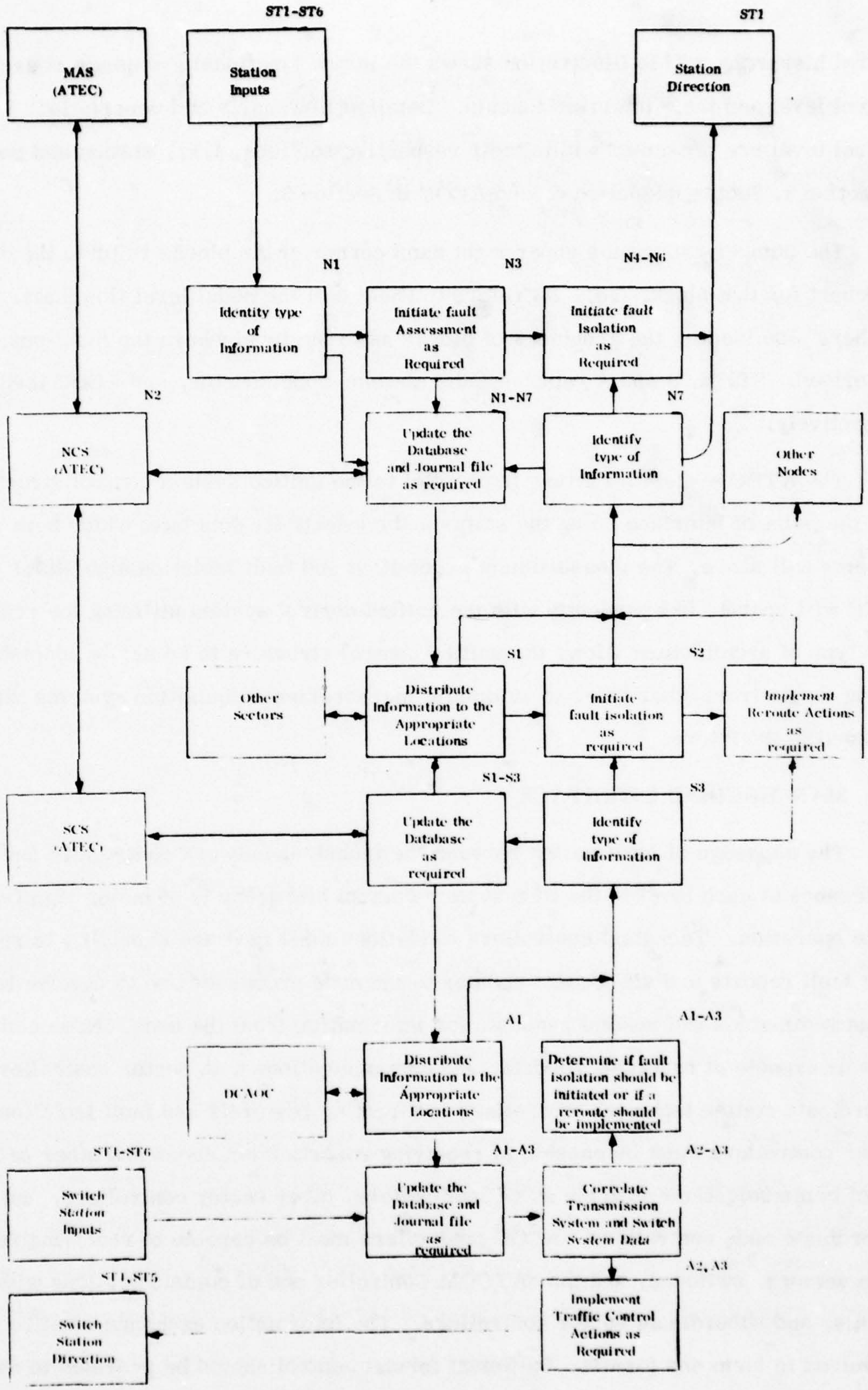


Figure 2-3. Unified System Control Flowchart

control hierarchy. This illustration shows the major functional groupings at each control level and their interrelationship. Detailed flowcharts and descriptions for each control level are presented within their respective sections, i.e., station and node are in Section 3, Sector in Section 4, and ACOC in Section 5.

The numbers above the upper right hand corner of the blocks refer to the detailed flowchart for that block, i.e., N3 refers to Sheet 3 of the nodal level flowchart. These numbers also identify the groupings of blocks as to the level where the functions are performed. ST, N, S and A represent the station, node, sector, and ACOC levels respectively.

The ATEC system structure is parallel to the unified system control structure with the point of interface being the status and connectivity data base which both systems will share. The measurement acquisition and fault isolation algorithms of ATEC will operate independently with the unified control system utilizing the results. This type of architecture allows the unified control structure to be easily adaptable to adding inputs from other types of automatic measurement acquisition systems that may be added in the future.

2.5 MAN/MACHINE INTERFACE

The exchange of information between the technical/network controllers and the processors at each level in the DCS system control hierarchy is of major significance in the operation. Technical controllers at stations must have the capability to speedily input fault reports and subsequent updates to the node processor and to receive fault status summaries and special requests for information from the node. Node controllers must be capable of receiving reports, and communications with Sector controllers and subordinate station technical controllers in directing restorals and fault isolation. Sector controllers must be capable of receiving reports from nodes and other sectors and of communications with the ACOC controllers, other sector controllers, and subordinate node controllers. ACOC controllers must be capable of receiving reports from sectors, switches, and the SATCOM Controller and of communications with other ACOCs, and subordinate sector controllers. The information exchange must be optimized in form and format. Sufficient format control should be provided to cause information request and response to be in plain language

information request and response to be in plain language clearly understandable by controllers. Each request from a controller position to the processor shall be acknowledged within 10 seconds.

The controller terminals at the ACOC, Sectors and Nodes should provide for visual displays and keyboard inputs with programmable function keys to facilitate information requests. A hard copy capability is also required at the above levels. Station controller terminals will be similar to those at higher levels. However, the need for a hard copy at stations with less than 120 terminating users may not be necessary.

2.6 DISPLAYS

The unified system control configuration shall provide the capability to display information at the ACOC, Sector, Node and Station levels. These displays should comprise an automatically updated display for summarized system status for use by the Node, Sector and ACOC controllers; major displays on request to satisfy more detailed status requirements; displays for preformatted entry of data by controllers; and displays to satisfy the need for special requests. The information to be displayed at each level is presented in Table 2-1 and are discussed in the following paragraphs.

2.6.1 System Status Summary

This is an automatic display for use by the node, sector and ACOC. It is intended to keep the controller aware of the status of that portion of the communications system within his jurisdiction. Figure 2-4 shows a recommended display for the Nodes and Sectors which are primarily transmission oriented. For all stations, links, trunks and circuits within the node or sector area of responsibility, the number of current outages and degradations will be constantly displayed. In addition as new faults are reported they shall appear as flashing indicators until acknowledged by the appropriate controller. Thus a node may show 6 circuit outages, 2 of which have not yet been acknowledged. This information can be continuously displayed on a monitor for a current awareness of system conditions and to alert the controller for the need to request additional details. At the ACOC, the system status summary monitor will include switch and

Table 2-1. Required Displays at Each DCS System Control Level

DISPLAYS	Stn	Node	Sector	ACOC
AUTOMATIC DISPLAYS				
System Status Summary		X	X	X
MAJOR DISPLAYS				
Detailed Fault Record	X	X	X	X
Station Fault Summary	X	X	X	X
Link Fault Summary	X	X	X	X
Trunk Fault Summary	X	X	X	X
Circuit Fault Summary	X	X	X	X
Connectivity	X	X	X	X
Switch Status Summary				X
AUTODIN Traffic Summary				X
AUTOVON Switch/Traffic Summary				X
Journal Data		X	X	X
DISPLAYS FOR ENTERING DATA				
Open Fault	X			
Update Fault	X	X	X	
Close Fault	X			
Report HAZCON	X			
Report PMP/QA Data	X			
Report Manual Fault Isolation Measurement	X			
SPECIAL REQUESTS				
Request for Manual Fault Isolation Measurement	X	X		
Request to Send Message to Another Position	X	X	X	X
Request to Initialize a Station Position	X			
Request for Manual Measurement			X	
Request for ATEC Status			X	
Request to Initiate Reroute Action				X
Request to Engage a Reroute Plan			X	
Request to Authorize a Reroute Action				X
Request to Confirm Reroute	X			
Request for PMP/QA Data		X	X	
Request to Issue Fault Status Notification			X	
Request to Modify Network Configuration				X

SYSTEM STATUS SUMMARY

SEVERITY	OUTAGES	DEGRADATIONS	NOT ISOLATED
STATIONS	NONE	1	NONE
		1	
LINKS	NONE	NONE	NONE
TRUNKS	1	NONE	NONE
CIRCUITS	6	1	3
	2		

Figure 2-4. System Status Summary

traffic status. In the case of AUTOVON, whenever a degraded switch or traffic condition is reported, the reporting switch identity and the report time will flash on the status monitor. The ACOC controller can then request the detailed fault indicator display at his CRT terminal. In the case of AUTODIN the system status summary will comprise the number of AUTODIN tributaries by switch, with out of threshold queues.

2.6.2 Fault Detail

This display shall identify all the known information concerning a fault. A recommended display layout is shown in Figure 2-5. This detailed fault information will be available on request at all control levels.

2.6.3 Station Fault Summary

This display shall summarize open hazardous condition reports and other station type outages by station. A recommended display layout is shown in Figure 2-6. This information will be available on request at all control levels.

2.6.4 Link/Trunk/Circuit Fault Summaries

These displays are consolidated summaries of the information contained in the detailed fault record and are intended to list all links, trunks and circuit faults by station, Node, Sector and ACOC, depending on the level requesting data. Recommended display layouts are shown in Figures 2-7 and 2-8. These summaries will be available on request at all control levels. The ACOC will encompass summaries of faults within their respective areas. The station level display will be restricted to links, trunks and circuits within the station level responsibility.

2.6.5 Connectivity

These displays are intended for use in manual fault isolation or for verification of trunk and circuit routing. Figure 2-9 shows an example of a circuit connectivity display. In this case the stations, trunks and channel assignment numbers are provided to the station controller to identify the routing and VF access points for a particular circuit.

FAULT DETAIL

FAULT NO 07200 RESPONSIBLE STATION: LKFTCF PRIORITY: 1A

RPTG STA: LKFTCF	SEVERITY: CIRCUIT
IDENT NO: BDFAR198	TIME OUT: 07/12/0930
DEGREE: OUT	DIRECTION: R
I/O STA: OUT	ISOLATED: NO
RFO:	EST REPAIR:
TIME RSTD:	RSTD CCSD:
HR FLT NO: NO	TIME IN:
REMARKS:	

Figure 2-5. Fault Detail

STATION FAULT SUMMARY

FAULT	STATION	DEGREE	TIME OUT	REMARKS
00612	LKFTCF	HAZCON	07/12/1420	HEATING SYSTEM MALFUNCTION

Figure 2-6. Station Fault Summary

LINK/TRUNK FAULT SUMMARY

FAULT	IDENT NO	DEGREE	ISOL	TIME OUT	EST REPAIR
00110	M0063	OUT	NO	07/12/0830	
00170	44JMD5	OUT	YES	07/12/1310	07/12/1530
00210	44CMM5	DEG	NO	07/12/1500	

Figure 2-7. Link/Trunk Fault Summary

CIRCUIT FAULT SUMMARY

FAULT	CCSD	DEGREE	ISOL	TIME OUT	TIME RSTD	EST REPAIR
00350	BDFAR198	DEG	NO	07/12/1300	07/12/1320	07/13/0900
00412	DRSAN675	OUT	YES	07/12/1510		07/12/1600
00212	FIAAN621	OUT	YES	07/12/1015		07/12/1830

Figure 2-8. Circuit Fault Summary

CIRCUIT CONNECTIVITY

CCSD: BDFAR198

STATION	TRUNK	CHANNEL
LKFTCF	44JMB5	2
DONTCF	44JMM5	9
KSLTCF	44CMM4	5
HDLTCF		

Figure 2-9. Circuit Connectivity

If trunk connectivity is desired the display will list the stations and links traversed by the trunk. This type of display can be made available on request at all control levels. However, it will be primarily utilized by the station level.

2.6.6 Switch Equipment Status Summary

These displays are summaries of the AUTOVON, AUTODIN, and AUTOSEVOCOM switch equipment status and identify those major equipment items that have been reported in an out of service condition. For example, the switch equipment status should comprise those equipment items identified in DCAC 310-55-1. This information will be available on request at the ACOC only.

2.6.7 AUTODIN Traffic Summary

This display is intended to alert the ACOC controller to message queue buildup at AUTODIN switches. Figure 2-10 is an example of this type of display which includes the switch identity, the affected channel number, the number of messages on queue/the number of messages for thresholding, and the date time group. The system status summary described previously will automatically indicate an out of threshold indication at the AUTODIN switch to trigger a request by the ACOC controller for the AUTODIN Traffic Summary.

2.6.8 AUTOVON Switch/Traffic Summary

This display will generally be used in conjunction with the system status summary described previously. The system status summary will automatically alert the ACOC controller to receipt of trouble indications from the AUTOVON switches. The ACOC controller can then request current status for a presentation of the reported conditions. Figure 2-11 is an example of the type of display that could be provided. A complete list of the indicators for display at the ACOC is presented in Section 6.

2.6.9 Journal Data

This type of display is intended for selective journal retrieval for information concerning such items as the types of actions implemented by the controllers,

AUTODIN ABNORMAL TRAFFIC SUMMARY

STATION	CHANNEL NUMBER	MESSAGES	TIME
CRODIN	093	42/35	07/13/1400
PMSDIN	010	240/200	07/13/1400
PMSDIN	282	36/30	07/13/1400
CLODIN	011	213/200	07/13/1415

Figure 2-10. AUTODIN Abnormal Traffic Summary

AUTOVON SWITCH/TRAFFIC SUMMARY

SWITCH ID	DTG	CONDITION
CTO	12/1020	SWITCH C.P.E. = 87% (DEGR)
CTO	12/1020	RSJ#3 C.P.E = 65% (DEGR)
CTO	12/1021	MF TRANSCEIVER OVERLOAD 2-22% MAINT BUSY
CTO	12/1022	CONTINUOUS ATB TO MTV
DON	12/1023	EXCESSIVE CALLS FROM LKF
HIN	12/1025	(NNX) (NNX) (NNX) ALTROUTES VIA LKF TO DON OVERLOAD - SUGGEST CANCEL

Figure 2-11. Example of AUTOVON Summary

reference of previously closed fault conditions, and access to PMP/QA measurements. The types of displays will be dictated by the specific information to be stored in the journal.

2.6.10 Displays for Entering Data

Displays for entering data are primarily associated with the station level and are intended to simplify the reporting process. Fault open, update, closure and HAZCON entry requests will result in a display similar to that described under Fault Detail Display and shown in Figure 2-5. The station controller will insert the appropriate information categories as required. Displays should also be provided for entering PMP/QA data and manual fault isolation measurements. In the latter case the information required is in response to an automatic request from the node and comprises a trunk, or CCSD identifier and the group pilot or VF channel signal level. In the former case the measurement information required in support of the DCS QA Program DCAC 310-70-57 will be inputted to the node for inclusion in the journal. Fault conditions resulting from such QA measurements which are not corrected immediately will be entered as degraded faults in the fault detail file.

2.6.11 Special Request Displays

The special request displays are required in support of the major displays and cover the initiation of control actions such as directing stations in manual fault isolation, directing circuit reroutes and others as listed in Table 2-1.

2.7 NETWORK/TRAFFIC FIGURES OF MERIT

Figures of merit provide a valuable tool to aid a network/traffic controller in assessing the performance of his communications media. Several of these currently exist and are used on a day to day basis to evaluate segments of the overseas DCS at the station level. These figures are developed within the Performance Monitoring Program (PMP) and include such daily parameter measurements as idle channel noise, receive signal level, and baseband loading. The technical control facilities maintain a continual record of these measurements and monitor the performance of the system down to the channel level. While this gives the technical controller valuable information on the operation of his equipment, a network controller needs a more consolidated figure of merit in order to be given an indication of the performance of the system within his area of responsibility.

Several criteria must be followed in developing useful network figures of merit. First of all, the data required to produce the figure of merit must be readily obtainable. This raw data must also be truely indicative of the condition being represented. One of the more important considerations is to be sure the figure of merit can be utilized by the network controller. It must provide the controller with an understandable picture of the situation in order to be useful. The figure of merit should not be too complex. That is, a trade-off must be made between the value of a figure of merit versus the quantity of data and complexity of computations required to arrive at the figure.

Many of the figures of merit developed and considered for evaluating the performance of the overseas DCS do not meet one or more of the above criteria and, therefore, are not recommended. For example, a figure of merit based upon the throughput of AUTODIN IST's would provide the AUTODIN network controller with an excellent tool in evaluating network traffic backlog conditions. Trending the throughput of the IST's would also help eliminate some traffic backlog conditions by determining a degrading trunk before traffic is severely affected. This figure of merit would be determined by a ratio of the number of NAK's received by a switch

and the total number of transmissions made for a given trunk. However, the NAK rates for the AUTODIN switches are not currently accessible, so this figure of merit cannot be calculated at the present time.

Those figures of merit that have been developed and are considered feasible to obtain and useful to the network controllers are described in the following paragraphs.

2.7.1 Call Processing Efficiency

This figure of merit provides the AUTOVON network controller with a single percentage figure that summarizes the current performance of a switch within the network. The percentage of call processing efficiency is computed by taking the ratio of the number of calls which the switch successfully completed and the number of calls which were attempted. This figure accurately reflects the effectiveness of the switch in successfully processing traffic.

2.7.2 Fault Severity

An indication of fault severity is derived from the fault assessment function that is performed at the node. This figure of merit summarizes the extent to which any one fault degrades the performance of the network. It is of particular use at the sector level in evaluating the need for establishing a reroute. The factors involved in determining this figure are the level of the fault (link, trunk, or circuit), the degree of degradation (out or degraded), priority, and estimated time to restore.

2.7.3 Network Availability

The purpose of this figure of merit is to ascertain the portion of the network that is available for use. This figure provides a network controller with a summary identifying what portion of the network is operational at any time. Calculating this figure involves combining the Fault Severity figures of merit to determine the degree of degradation of performance within the network.

Each Fault Severity figure of merit for the portion of the network being examined (node, sector, or theater) must be reduced to the total number of circuits being affected. For example, a Fault Severity of a trunk being carried in an outage condition

would be counted as twelve circuits in an outage condition. The number of circuit outages and degraded circuits are then totaled by priorities. Next, each circuit total is weighted by the factors shown below:

Circuit Priority	Weighting Factor Outage	Weighting Factor Degradation
1	10	5
Other	2	1

The weighted totals are now added and the sum is the adjusted figure representing the effective degree of circuit degradation. This number is then subtracted from the total number of circuits within the portion of the network being analyzed, the percentage of circuits remaining being the figure of merit.

Take, for example, a theater level analysis within Europe. Assume at the time of request the distribution of degradations of a link outage consisting of 50 priority 1 circuits and 130 of lesser priority, 3 trunk outages consisting of 8 priority 1 circuits and 28 of lesser priority, 18 circuit outages consisting of 3 priority 1 and 15 lower priority circuits, and 26 degraded circuits of lesser priority. The circuit totals are shown below:

Circuit Priority	Totals Outage	Totals Degradation
1	61	0
Other	173	26

Multiplying these totals by the weighting factors and adding results in a weighted degradation of 982. Subtracting from a total number of actual circuits of approximately 10,200 arrives at a total of 9218, making the figure of merit for these conditions 92 percent. This percentage will give the network controller a single figure summary of the relative condition of the network.

This figure of merit can be calculated for different levels of the unified control hierarchy. Each nodal, sector, or network controller can be given a figure for his area of responsibility. The network controller at the ACOC could be given

a theater figure of merit, as well as figures by sector and node. The controller could then determine the degraded areas of the system when network availability is down.

2.7.4 Congestion

An indication of traffic congestion within the AUTODIN network is determined by thresholding message queue lengths on the switch traffic summaries. Any channel with an exceeded threshold will be examined for any degraded indications within the control structure. This information is compared to determine if the excessive queue is because of a heavy volume of traffic or possibly because of difficulty in the circuit. This figure of merit can assist the AUTODIN controller in identifying choke points within the AUTODIN system.

2.7.5 Percent Trunk Utilization

Percent trunk utilization on AUTOVON trunk groups will provide the traffic distribution and choke point identification for the AUTOVON network. Data from each of the AUTOVON switches is collected and the percent of usage by trunk group is calculated. This figure of merit also assists the AUTOVON controller in making traffic control decisions during periods of excessive traffic loading within the network.

SECTION 3 - NODE REQUIREMENTS

3.1 FUNCTIONAL DESCRIPTION

This functional description encompasses the functions performed at the nodal level of the Unified Control System. Functions performed at each of the different types of stations which are the sources of information for the nodes are also outlined.

In the detailed flowcharts that follow many connections between pages were required because of the complexity of the diagrams. A continuation to or from a different page is shown by a circle with a number in it. The numbering system is the same as that used on the general flowchart . If a circle contains N3-1 the flow continues on Sheet 3 of the nodal level flowchart, the second number distinguishing different inputs on the same page. A single circle indicates the flow is information only, and two concentric circles indicate that the flow is control and direction as well as information.

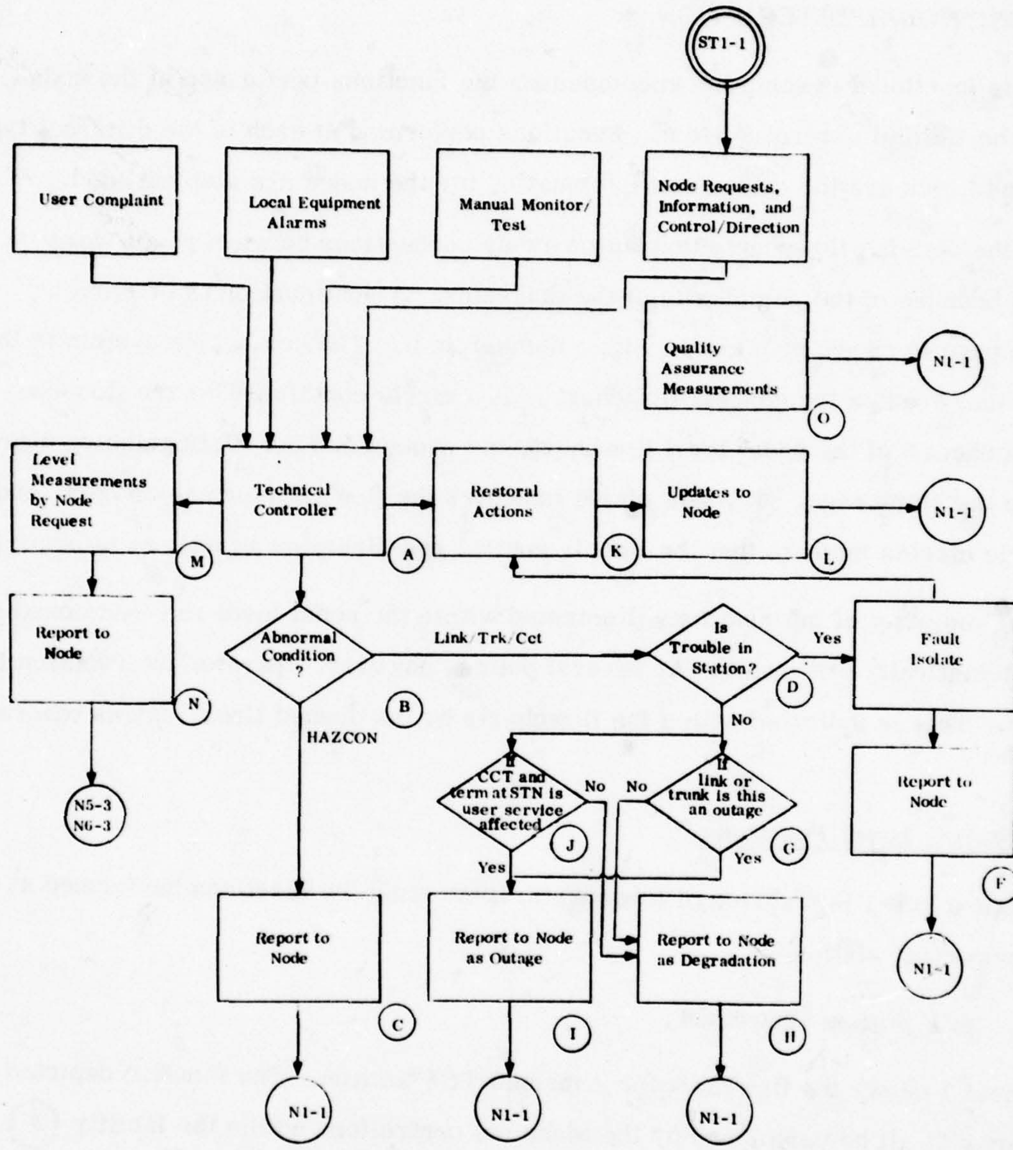
The majority of the functions illustrated within the nodal level are envisioned as being automatically processed. At several points, however, operator intervention is required. This is indicated within the flowcharts by the dashed lines, unless otherwise noted.

3.1.1 Station Level Functions

Figure 3.1-1 is a series of flowcharts illustrating the functions performed at each type of reporting station.

3.1.1.1 TCF Station Flowchart

Sheet 1 shows the flowchart for a manual TCF station. The function depicted on this chart will all be performed by the technical controllers within the facility (A) . The controller will be aware of the status within the station by way of user complaints, local equipment alarms, and manual monitoring and testing. The controller must assess the condition of any problem that arises (B) . If he determines a hazardous condition exists, it will be reported to the node as such (C) . If a link, trunk, or circuit problem



Note: All actions and decisions performed by technical controller.

Figure 3.1-1. Station Level Functional Flowchart (Sheet 1 of 6) TCF

exists the controller must make the determination if the problem is within the station (D). If it is, he will isolate the fault (E), report it to the node as a station problem (F), and initiate restoral actions (K).

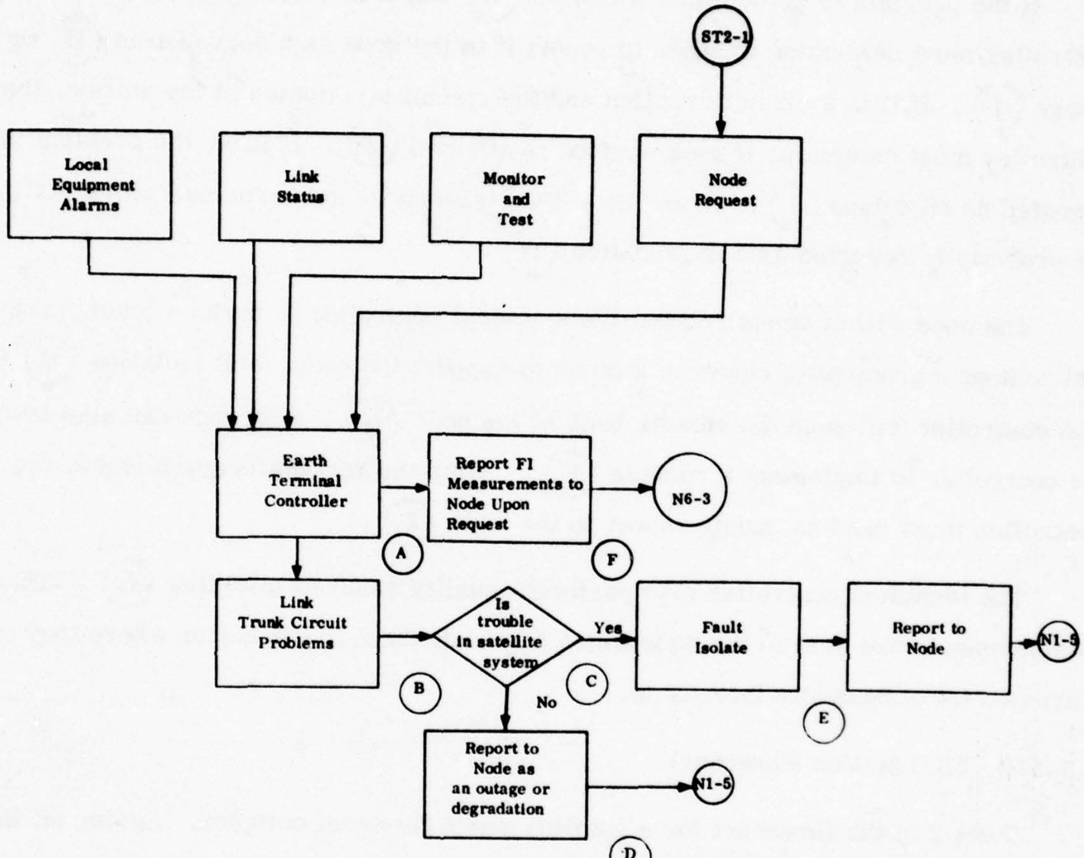
If the problem is not within the station (D) and it is a link or trunk problem (G), controller must determine whether to report it to the node as a degradation (H) or an outage (I). If it is a circuit problem and the circuit terminates at the station, the controller must determine if user service is affected (J). If it is, the problem is reported as an outage (I). If not, or if the circuit does not terminate at the station, the problem is reported as a degradation (H).

The node will at times request the technical controller to make a level check on a circuit or a group pilot check on a trunk to support the nodal fault isolation (M). The controller will send the results back to the node (N). The node can also instruct the controller to implement a reroute (K). After the reroute is established, the controller must send an update report to the node (L).

The technical controller also performs quality assurance testing (O). These measurements are sent to the node which forwards them to the sector where they are journaled for access at a later time.

3.1.1.2 ETC Station Flowchart

Sheet 2 is the flowchart for a satellite earth terminal complex. Again, all the functions shown will be performed by the controllers within the facility (A). Status within the station will be derived from local equipment alarms, satellite link status, and monitoring and testing. The earth terminal controller will assess any link, trunk, or circuit problems (B) and determine if the problem is within the satellite system (C). If it is, the controller will initiate fault isolation (E) and report the problem to the node as fault isolated to the satellite system. If the problem is not within the satellite system (C) the controller will report the fault as an outage or a degradation to the node (D). The node can also request the earth terminal controller to input information in support of fault isolation (F).



Note: All actions and decisions performed by technical controller.

Figure 3.1-1. Station Level Functional Flowchart (Sheet 2 of 6) Earth Terminal Complex

3.1.1.3 AUTODIN Station Flowcharts

Sheet 3 shows the transmission oriented information flow at AUTODIN switch stations. AUTODIN switch alarm points (A) are automatically scanned and initiate "U" line report preparation within the processor (B) . Upon generation of a report a request is printed out to the PTF for an RFO code (C) . The AUTODIN personnel must then determine if it is a switch equipment problem or a problem outside of the switch station (D), and input the appropriate RFO code (E)(F). Upon receipt of the RFO code or after 4 minutes, whichever comes first, the report will be sent off to the node (G) .

The node will send information to the station regarding the status of AUTODIN circuits and make requests of the AUTODIN controller for information (H) . The controller can manually input status to the node (I), and will return level measurements when requested by the node to support fault isolation (J) .

Sheet 4 of the station level flowcharts illustrates the functional flow of AUTODIN station traffic monitoring. The switch personnel take traffic STAT's periodically to monitor the traffic within the switch (A) . The traffic data is periodically sent to the ACOC (B) , although not as often as it is reviewed at the station. The switch operators examine the queues built up within the switch to determine if they are all within threshold (C) . If they are not, or if a threshold is being approached, the operator must establish if the condition has been previously reported (D) . If it has not, the operator will inform the ACOC of the backlog condition (E) and send the current traffic status immediately and each time the station takes them (F) . The switch personnel will then determine appropriate control actions (G) , utilizing circuit status information provided by the node and local alarms at the switch (I). The ACOC must be notified of the intended actions and will verify them and/or instruct the switch operator to implement other controls (H).

The station personnel will continue to monitor the traffic. If the condition is stabilizing or improving (L), no further action is required until the condition is cleared enough to remove the controls. If the condition is still degrading (L) , the control

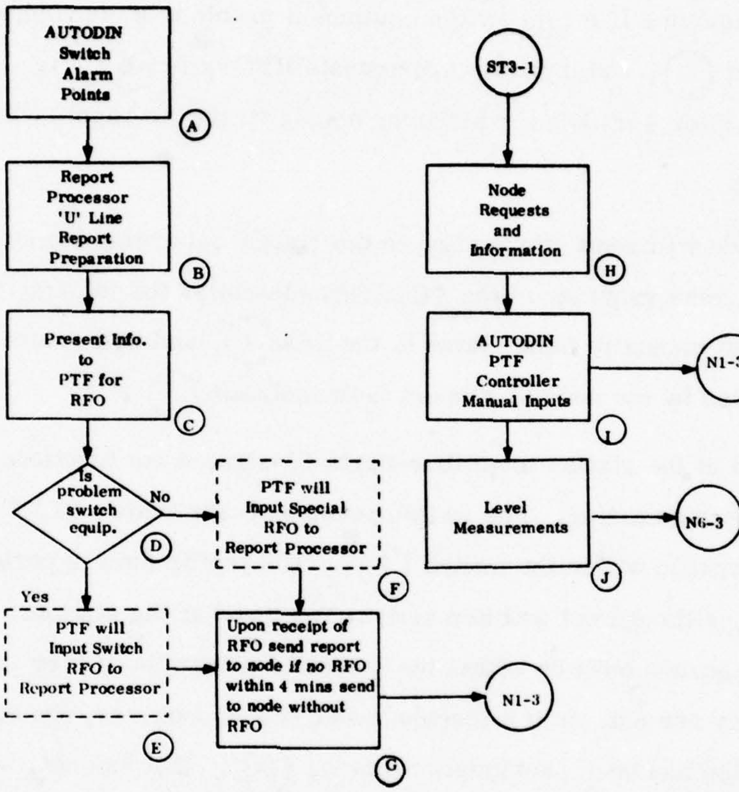
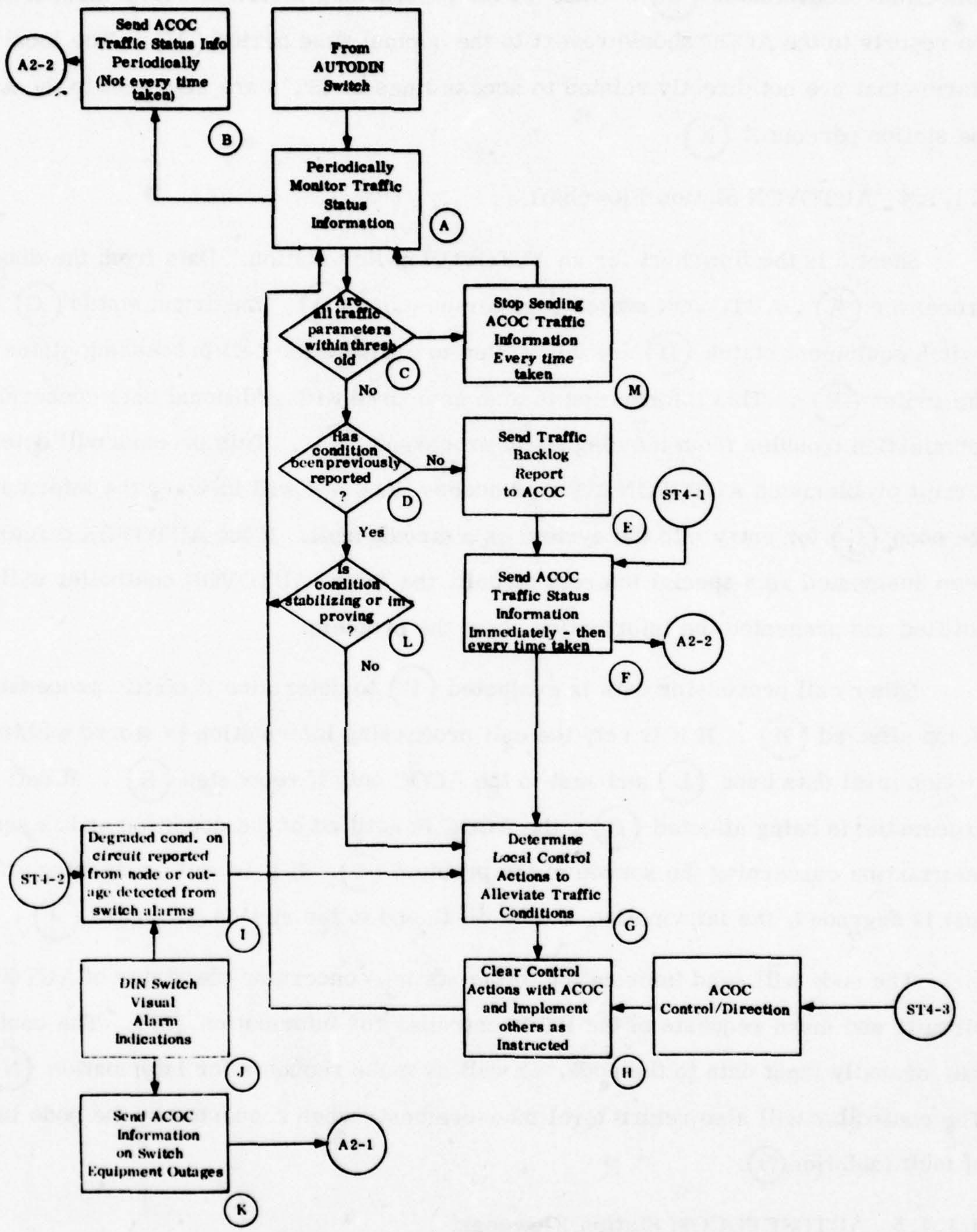


Figure 3.1-1. Station Level Functional Flowchart (Sheet 3 of 6) AUTODIN



Note: All actions and decisions performed by AUTODIN controller.

Figure 3.1-1. Station Level Functional Flowchart (Sheet 4 of 6) AUTODIN

actions are reevaluated (G). Once all the parameters return to within threshold (C), the reports to the ACOC should revert to the normal time period (M). The local switch alarms that are not directly related to access lines or IST's are also sent to the ACOC by the station personnel (K).

3.1.1.4 AUTOVON Station Flowchart

Sheet 5 is the flowchart for an AUTOVON switch station. Data from the diagnostic processor (A), AUTOVON switch register memory (B), line/trunk status (C), and switch equipment status (D) are correlated to evaluate the call processing status within the switch (E). This information is also compared with additional data concerning line termination troubles from the diagnostic processor (F). This process will determine circuit problems on AUTOVON IST's or access lines and will forward the information to the node (G) for entry into the system as a circuit fault. If the AUTOVON circuit has been designated as a special interest circuit, the ACOC AUTOVON controller will be notified and presented the information about the problem.

Other call processing data is evaluated (E) to determine if traffic processing is being affected (H). If it is not, the call processing information is stored within the station level data base (L) and sent to the ACOC only if requested (K). If call processing is being affected (H), the ACOC is notified of the condition and is sent information concerning the source of the problem (I). If it is call processing efficiency that is degraded, the information will be displayed to the station personnel (J).

The node will send information to the station concerning the status of AUTOVON circuits and make requests of the PTF controller for information (M). The controller can manually input data to the node, as well as make requests for information (N). The controller will also return level measurements when requested by the node in support of fault isolation (O).

3.1.1.5 AUTOSEVOCOM Station Flowchart

Sheet 6 is the functional flowchart for an AUTOSEVOCOM station. This station, like the TCF and ETC stations, provides manual inputs with the PTF controller performing the functions illustrated (A). The sources of information available to the

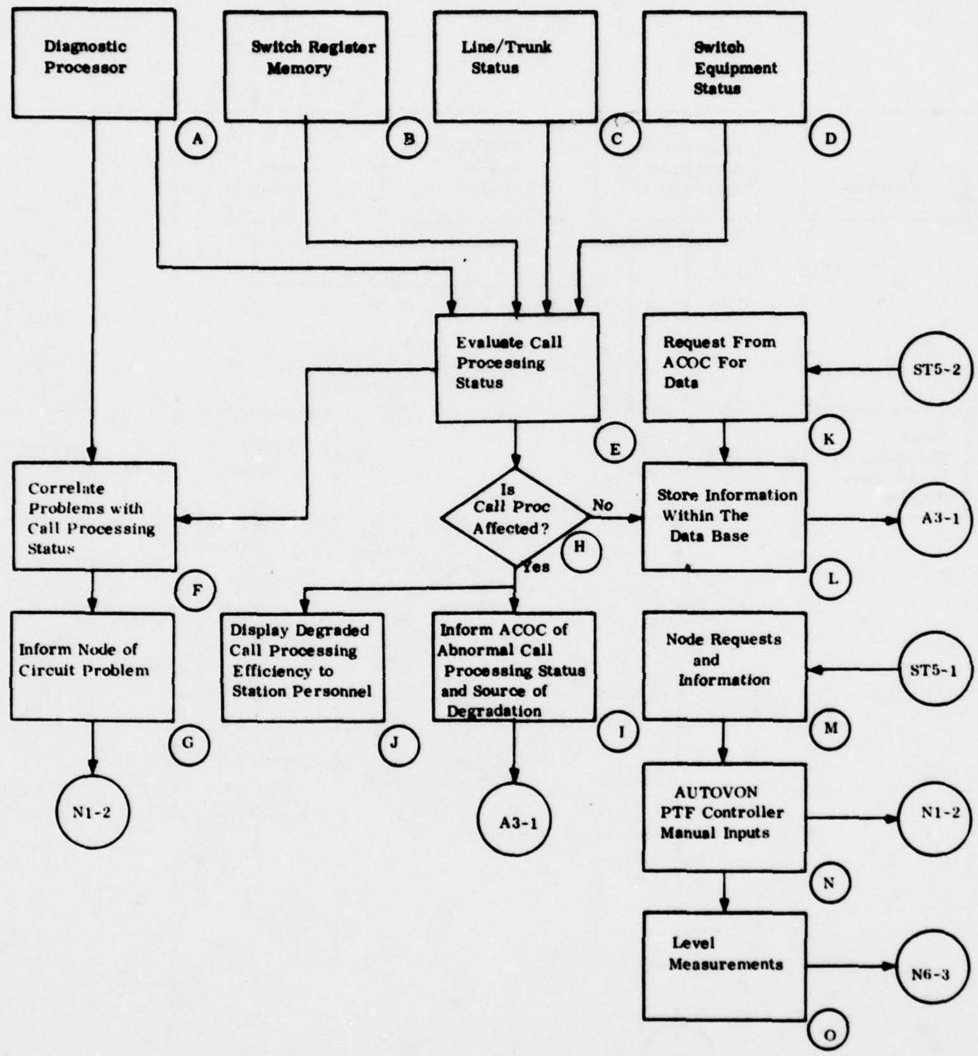
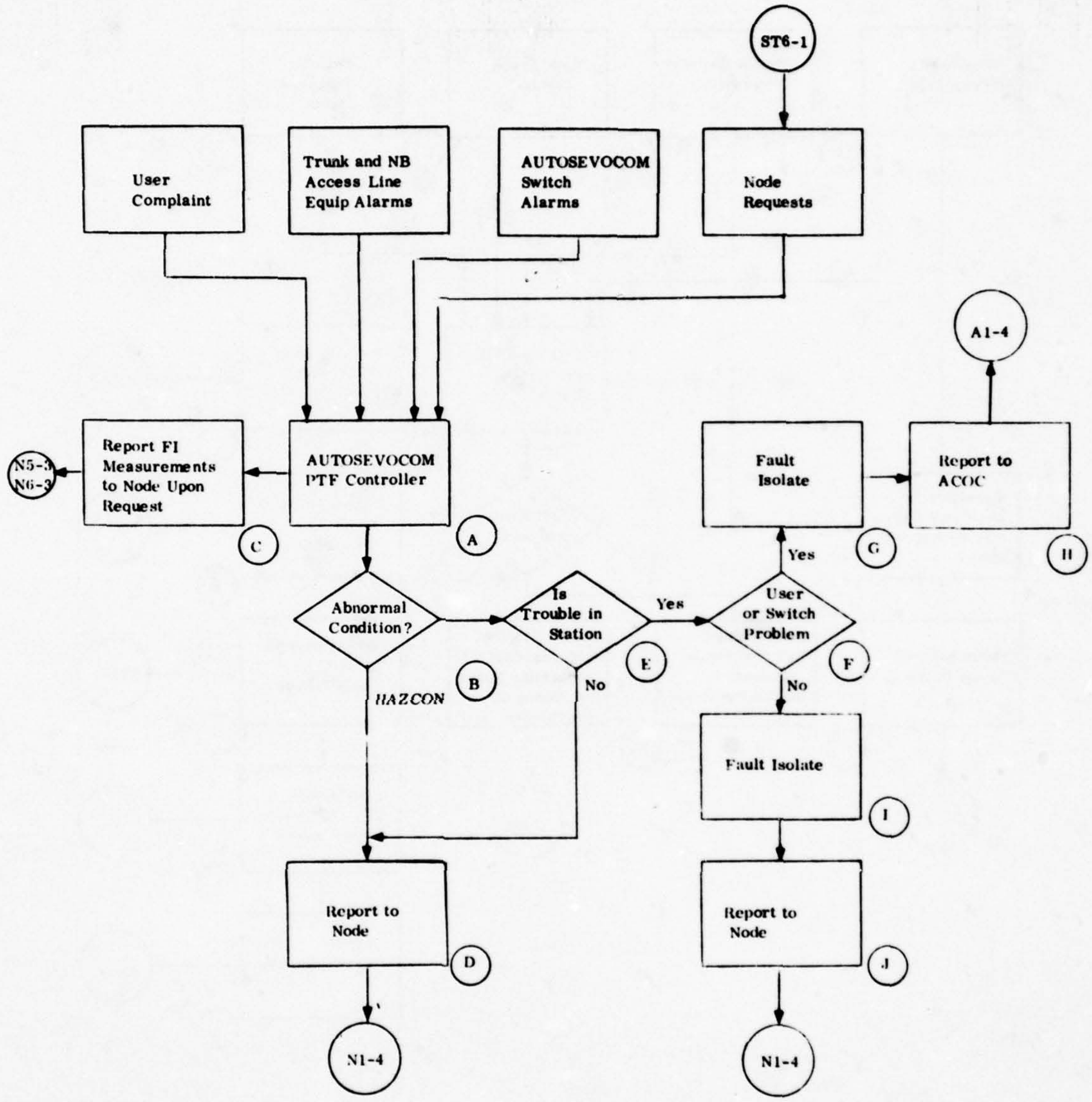


Figure 3.1-1. Station Level Functional Flowchart (Sheet 5 of 6) AUTOVON



Note: All actions and decisions performed by technical controller.

Figure 3.1-1. Station Level Functional Flowchart (Sheet 6 of 6) AUTOSEVOCOM

controller are user complaints, trunk and narrow band access line equipment alarms, and AUTOSEVOCOM switch alarms. If upon assessing the condition of the station (B), the controller determines a hazardous condition exists, he will report it to the node (D). If there is a trunk or narrow band access line problem, the controller must determine if the trouble is located within the station (E). If not, the fault is reported to the node as an outage or a degraded condition (D).

If there is a problem within the station involved with the switch or a user (F), the PTF controller will initiate fault isolation actions (G), and send the information to the ACOC (H). If there is a trunk or narrow band access line problem that is within the station (E) (F), the controller will initiate fault isolation (I) and inform the node that there is a problem that has been isolated to the station (J). The node can also request the PTF controller to input information in support of fault isolation (C).

3.1.2 Nodal Level Functions

Figure 3.1-2 is the functional flowchart for the node. Sheet 1 shows the inputs originating at satellite earth terminal complexes, AUTOVON, AUTOSEVOCOM, AUTODIN, and manual TCF stations. The node initially examines the inputs to determine what type of information is being reported from the stations. First, if the information concerns a newly discovered fault (A), the fault assessment routine (Sheet 3) at the node is initiated. If not, the node determines if the station is updating the status of a previously reported trouble. In the case when the station is reporting that an outage has been rectified and the situation is back to normal (B), the node will journal the fault detail record associated with that outage (D). The node will also inform all TCF's that originally reported the problem that the problem is now corrected. The fault will then be deleted from the data base (E), and the information will be forwarded to the sector (F). If the report is just updating the status of a current outage (C), the node will update the information within the data base (E) and send the information to the sector. Each time the data base is updated nodes which have an AUTOVON or AUTODIN switch within their areas will enter the routine on Sheet 4 to distribute circuit status to the appropriate switch status.

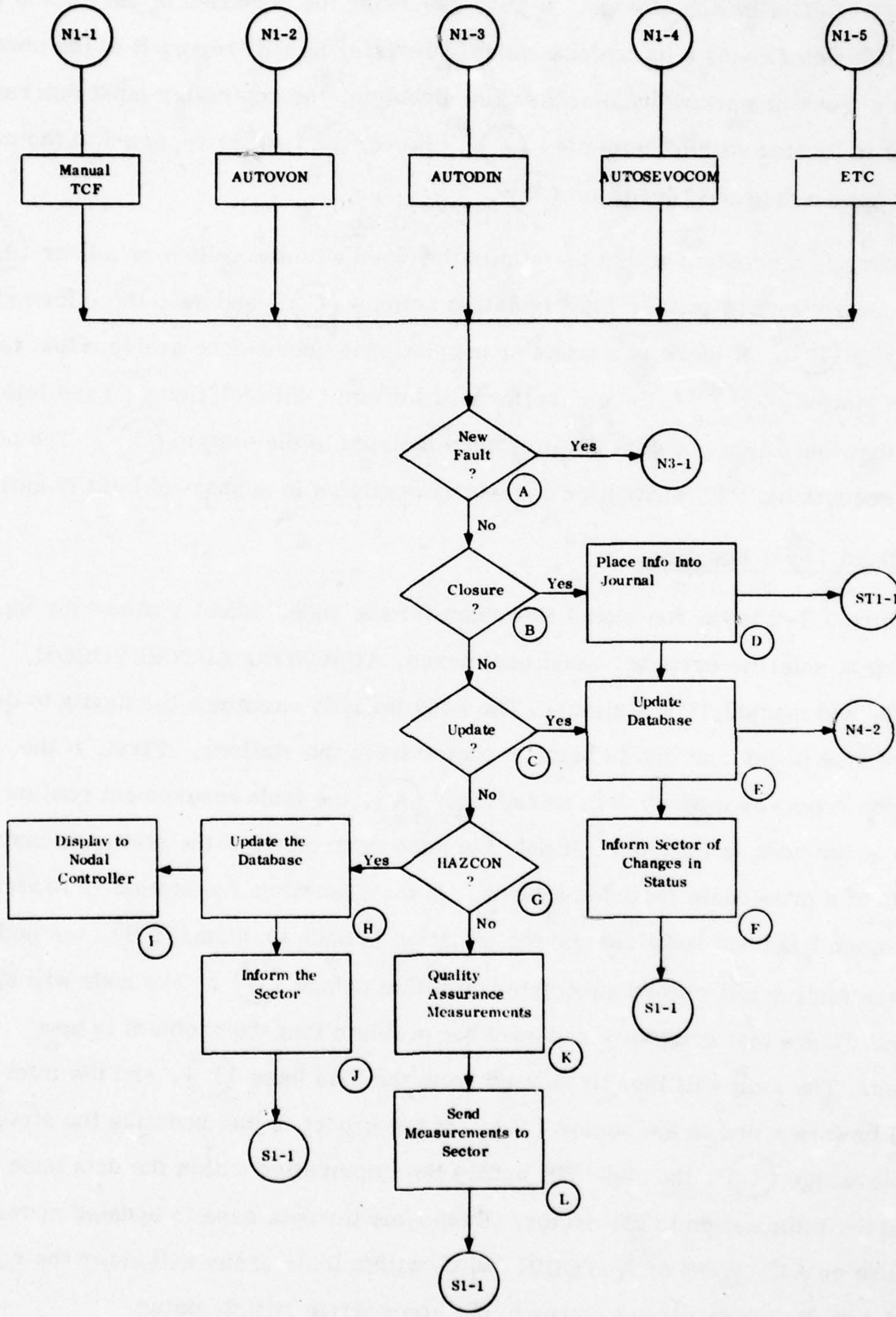


Figure 3.1-2. Nodal Level Functional Flowchart (Sheet 1 of 7)

If the report is concerning a hazardous condition at a station (G), the node will store the information within its data base (H) and forward the information to the sector (J). The nodal controller will be kept informed of HAZCON's within his nodal area by receiving displays of the information as it is reported (I).

The node will also receive quality assurance measurements made at the stations (K). These measurements will not be acted on by the node, but will be forwarded to the sector for journaling (L).

Sheet 2 shows the inputs originating at ATEC equipped stations. The ATEC measurement acquisition and fault isolation algorithms will operate independently from the unified system control information flow, as discussed in Section 2, with the interface being the status information exchange. When an alarm condition is received from a station measurement acquisition subsystem (MAS) at the nodal control subsystem (NCS) (A), the NCS will first check the nodal data base to see if there is a fault isolated report related to the problem that has been detected by the MAS (B). For example, if the MAS discovers a circuit problem, the nodal data base may already contain the information that the circuit is out because of a trunk problem in another part of the system. If there is no related report ATEC will proceed with its fault isolation process (C) and the nodal data base will be updated to include the fault (E). If the fault has already been isolated, ATEC will cancel its fault isolation routine (D).

Sheet 3 of the functional flowchart shows the performance assessment that is done within the node. This routine is entered from Sheet 1 for all newly reported faults from stations within the nodal area with the exception of ATEC detected faults. The node will first look to see if the fault is isolated; that is, the station is reporting a fault and has already determined the reason for outage (A). If this is the case then the information updates the data base (B), and the information distribution routine on Sheet 4 is entered if an AUTODIN or AUTOVON switch is within the nodal area. The node will then determine if it is currently processing any related outages or degradations (C), and if so, cancel the fault isolation that is in progress (D). In either case, the information will be sent to the sector (E).

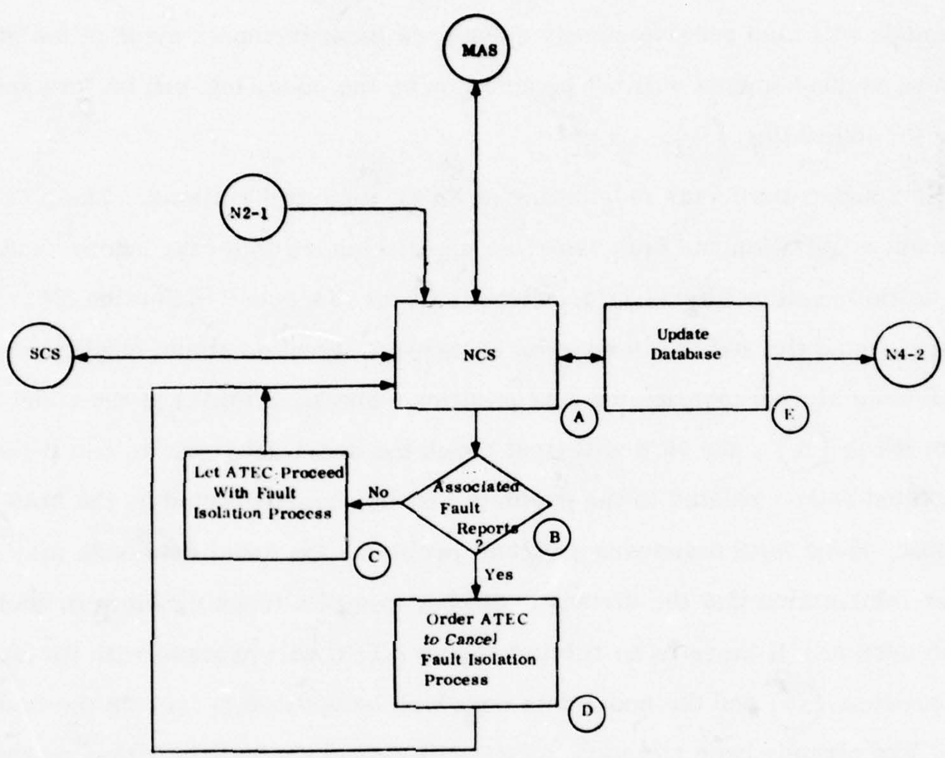


Figure 3.1-2. Nodal Level Functional Flowchart (Sheet 2 of 7)

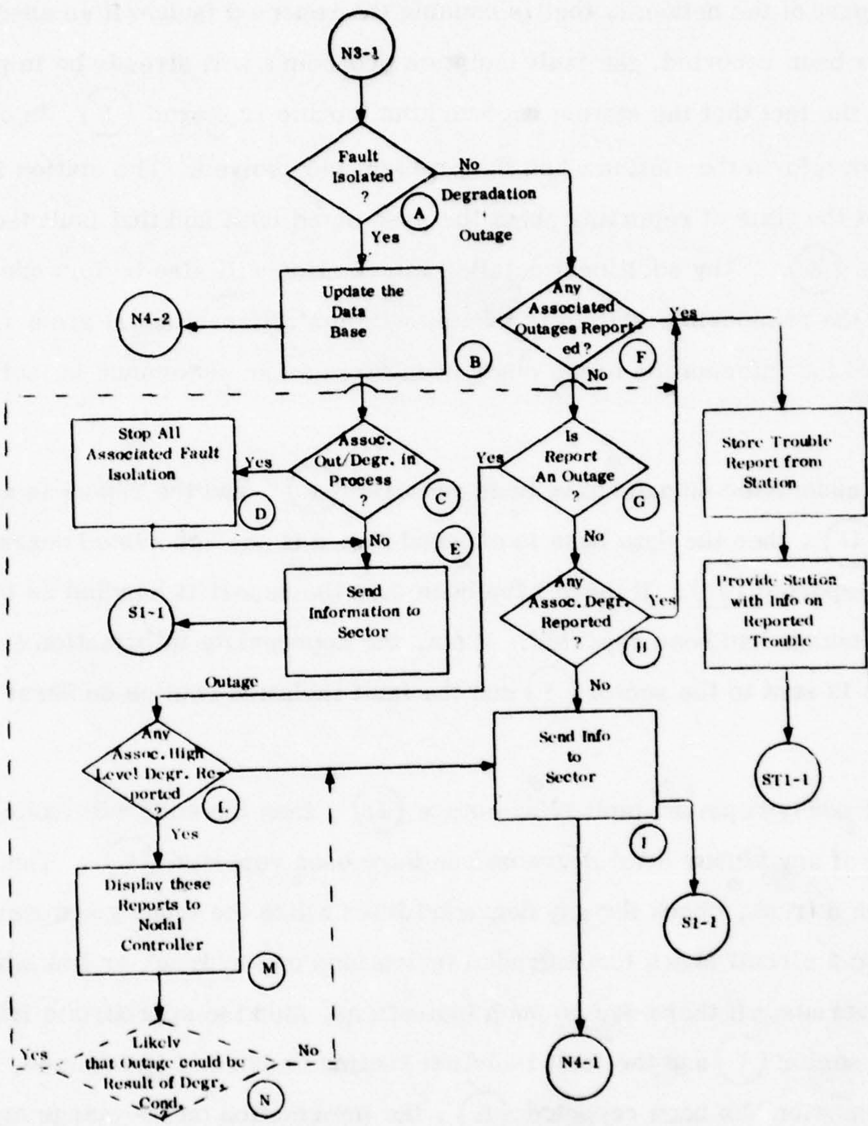


Figure 3.1-2. Nodal Level Functional Flowchart (Sheet 3 of 7)

If the fault is not isolated (A), the data base is examined to determine if any associated outages have been reported (F). This could be an equal level problem that was reported earlier by a different station, or a higher order problem, perhaps from a different part of the network, that is causing the reported fault. If an associated problem has been reported, the fault isolation procedure will already be in progress. Therefore, the fact that the station reported the trouble is stored (J), in order that the node can inform the station when the problem is resolved. The station is also informed at the time of reporting about the associated fault and that fault isolation is in progress (K). Any additional detailed information will also be forwarded to the sector. If the responsible station is located within a different nodal area, the sector will forward the information to the other nodal area as an assistance in isolating the problem.

If no associated outages have been reported (F), and the report is a degraded condition (G), then the data base is checked to see if any associated degradations have been reported (H). If there have been then the report is handled as through an associated outage had been reported. If not, the appropriate information (as described previously) is sent to the sector (I) and the fault isolation routine on Sheet 4 is initiated.

If the newly reported fault is an outage (G), then the node will examine the data base to see if any higher level degradations have been reported (L). That is, if the report is on a trunk, check for any degraded links which the trunk goes over, or if the report is on a circuit check for degraded indications on any trunk or link which the circuit traverses. If there are no such indications, then the appropriate information is sent to the sector (I) and the fault isolation routine on Sheet 4 is initiated. If a higher order degradation has been reported (L), the information on the outage and degradation is displayed to the nodal controller (M) who must decide if the outage condition has most likely been caused by the degraded link or trunk (N). If the controller determines the problems are related, the report is stored so the station can be informed when the fault is corrected (J). The station is also immediately informed of the higher order trouble

and that work is in progress (K) . If the controller decides the outage is not related to the higher order degradation, the information is sent to the sector (I) as a new fault and the nodal fault isolation routine is started.

Sheet 4 shows the information distribution to AUTODIN and AUTOVON switch stations as well as the initial steps of the fault isolation routine. New fault information, entering this routine at N4-1, is first entered into the nodal data base (A) . If the station designated as being responsible for manual fault isolation, if required, is within this nodal area, all of the detailed fault information is stored. If the responsible station is not within this nodal area, only a summary of the fault is maintained; the detailed information having been forwarded to the appropriate node via the sector.

Those nodes which have an AUTODIN switch within their area check the new reports, as well as all other new and update information from the sector, stations, or ATEC (entering at N4-2), to see if an AUTODIN circuit is affected (B) . If so, the node will display the information on the degraded circuit to the AUTODIN switch station personnel (C) , as described earlier in the station descriptions. Likewise, nodes which have an AUTOVON switch within their area will check all new and update information for an affected AUTOVON circuit (D) . When a circuit is affected, the information will be sent to the AUTOVON station for display to the station personnel (E).

The newly reported problems from the satellite earth terminal complexes, AUTOVON, AUTOSEVOCOM, AUTODIN, and manual TCF stations also initiate the fault isolation routine. If the reported fault is on a link (F) , the node checks to see if the link is equipped with ATEC (G) . If so, ATEC is requested to make an immediate monitor on the link (I) and will communicate with the stations through its own routines. If the link is not equipped with ATEC, the node will pass the information it has on the problem to the stations (or station if the link crosses the nodal boundary) which terminate the link and instruct them to coordinate and fault isolate the problem (H) .

If the reported fault is not on a link (F) , and is on a trunk (J) , then the trunk fault isolation routine on Sheet 5 is initiated. If the problem is not on a trunk, then the node proceeds to the circuit routine on Sheet 6.

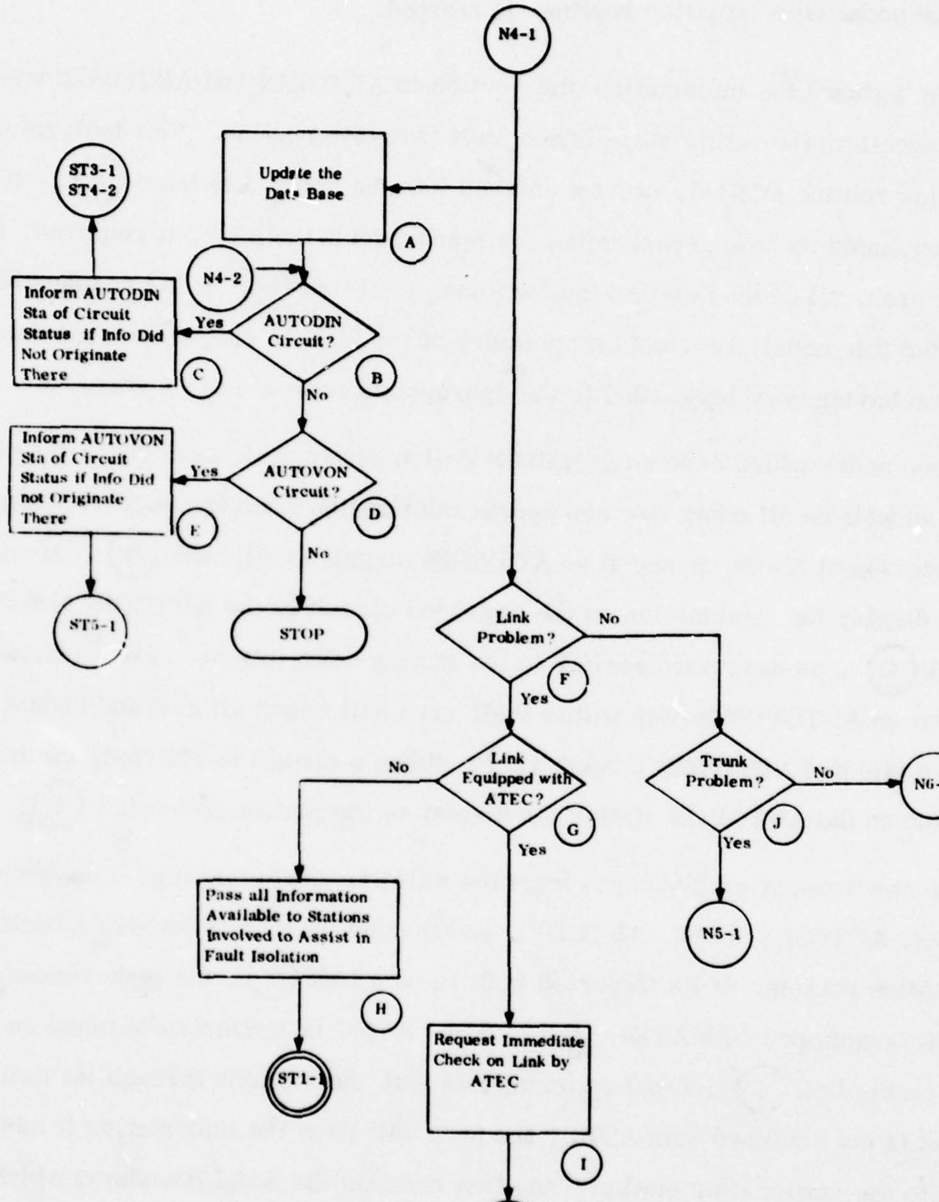


Figure 3.1-2. Nodal Level Functional Flowchart (Sheet 4 of 7)

Sheet 5 shows the fault isolation algorithm at the node for trunk related problems. The first action taken by the node is to check to see if the trunk is equipped to be monitored by ATEC (A). If not, the data base is examined to determine if the trunk is contained completely within the nodal area (B). If it is not, the node will wait for a command from the sector to proceed (C). This pause is to allow the sector to check the other nodes involved to see if any are equipped with ATEC to monitor the trunk. If so, the sector will wait for the results from ATEC before commanding the nodes to initiate the manual fault isolation. This will utilize the capabilities of ATEC to rapidly perform measurements, which will reduce and possibly eliminate, depending upon the location of the fault, the amount of unnecessary manual fault isolation performed.

If the trunk is contained within the nodal area (B), or the node has been told to proceed by the sector (C), the node will instruct each station which the trunk passes through to make a group pilot check (D). This information will be entered by the station personnel stored in the data base (U) and displayed to the nodal controller (E). The controller will review the information to determine if any problem was revealed by the group pilot measurements (F). If so, but the problem appears to be entering from an adjacent node (G), the information on the abnormality found will be sent to the sector (J). If the problem is within the nodal area (G), the stations involved are given information about the fault by the node and instructed to proceed with fault isolation (H). The sector is also informed that the problem has been isolated to this nodal area (J). This allows the sector to stop all other fault isolation in progress within other nodal areas. The sector may also direct the node to instruct a station at the nodal boundary to coordinate with the boundary station of another node when the sector determines the problem is between the two nodal areas (I).

If the nodal controller determines that the group pilot level with his nodal is normal (F), the sector is informed that no problem was found (K). If the station responsible for manual fault isolation is not within the nodal area (L), the node maintains the information on the trunk (M), and takes no further action unless directed

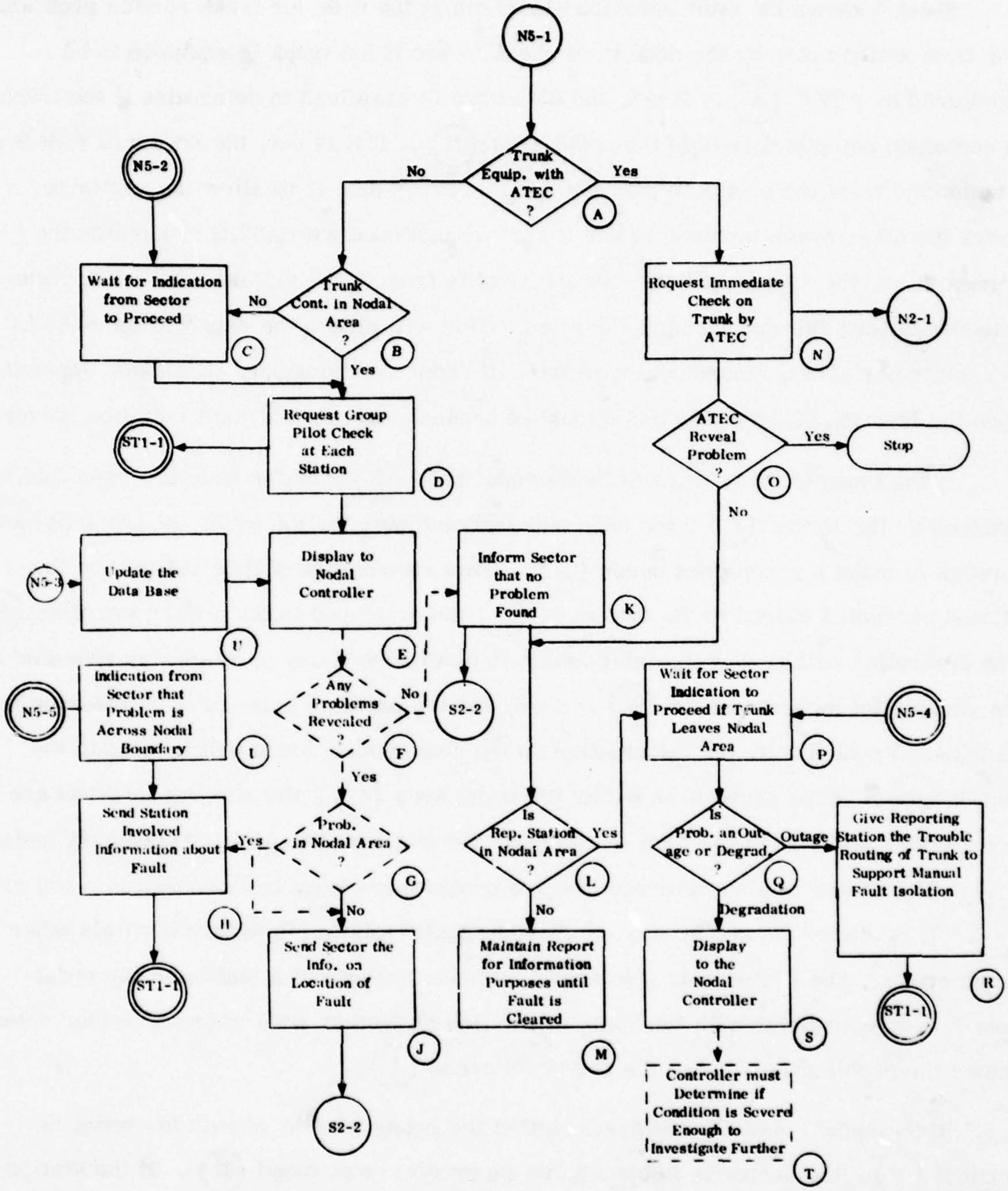


Figure 3.1-2. Nodal Level Functional Flowchart (Sheet 5 of 7)

to by the sector. If the responsible station is within the nodal area (L), and the trunk leaves the nodal area, the node will again wait for an indication to proceed from the sector (P), which is examining the results from other nodal areas. Once the node receives the indication to proceed or if the trunk is contained within the nodal area, and the problem is an outage (Q), the node will give the responsible station the routing of the trunk and instruct the personnel to initiate manual fault isolation (R). If the problem has been reported as a degradation (Q), all the information available is displayed to the nodal controller (S) who must decide if the condition is severe enough to warrant further investigation (T).

If the trunk is equipped to be monitored by ATEC (A), the node will request a immediate monitor (N). If ATEC reveals a problem (O), this routine stops and the ATEC system will proceed and inform the controller of the results. If ATEC does not reveal a problem (O), the routine proceeds in the same manner as if no problems were found with the manual level checks.

Sheet 6 shows the fault isolation algorithm for circuit related problems. The node first checks to see if the circuit is equipped to be monitored by ATEC (A). If it is not, the data base is examined to determine if the path of the circuit is contained within the nodal area (B). If not, the node will wait for a command from the sector to proceed (C). This pause is to allow the sector to check the other nodes involved to see if they are equipped with ATEC, and if so to check them first.

If the circuit is contained within the nodal area, the database is examined to determine if the circuit has a level to monitor (D). If so, or if the circuit leaves the nodal area and the sector directs the node to proceed, the node will request a level monitor from each station which the circuit passes through (E). The measurements will be entered by the station personnel, stored in the data base (V), and displayed to the nodal controller (F). The controller will review the information to determine if any level problems are revealed (G). If so, but the problem is entering from another nodal area (H), the information found is sent to the sector. If the problem is within the nodal area, the stations involved are given the information on the fault and instructed

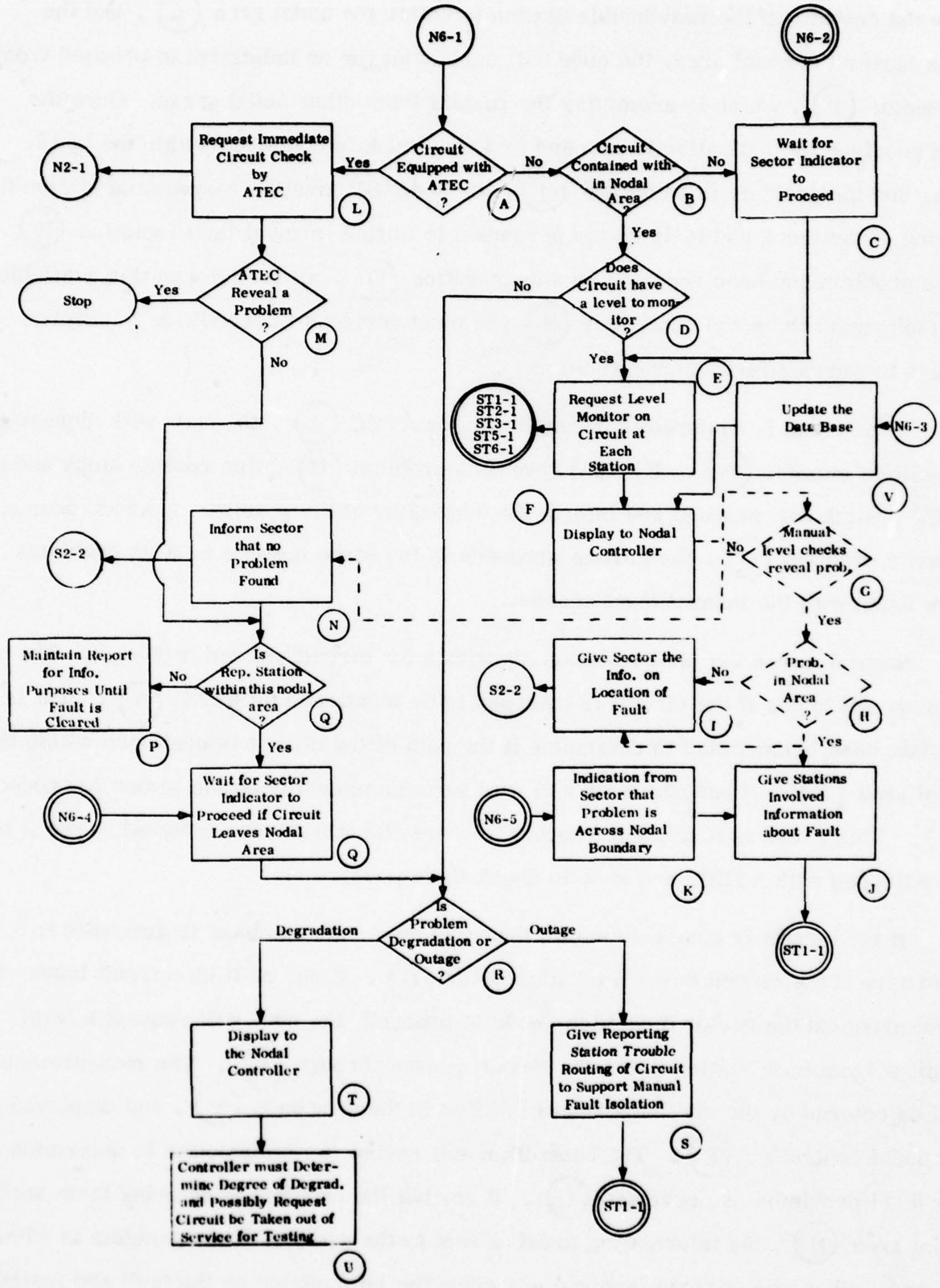


Figure 3.1-2. Nodal Level Functional Flowchart (Sheet 6 of 7)

to proceed with fault isolation (J) The sector is also informed that the problem is within this nodal area (I) so the sector can cancel other fault isolation in progress. The sector can also direct the node to have a station on the nodal boundary coordinate with a station in an adjacent nodal area to fault isolate troubles across the nodal boundary (K).

If the nodal controller determines that nothing is revealed by the level checks (G), the sector is informed that no problem was found (N). If the station responsible for manual fault isolation is not within the nodal area (Q), the node will store the information on the fault (P), but will take no further action unless instructed by the sector. If the responsible station is within the nodal area, and the circuit leaves the nodal area, the node will wait for direction from the sector to proceed (Q). This pause is to allow the sector to examine the results from other nodal areas. If the circuit is contained within the nodal area, the node has been given the indication to proceed, or the circuit has no level to monitor (D), the node will check to see if the report was an outage or a degraded condition. If it is an outage, the node will give the responsible station the routing of the circuit and instruct the personnel to begin manual fault isolation (S). If the problem has been reported as a degradation (R), all the information available is displayed to the nodal controller (T). The controller must assess the severity of the degradation and determine if a request should be made to take the circuit out of service for further testing (U).

If the circuit is equipped to be monitored by ATEC (A), the node will request an immediate monitor on the circuit (L). If ATEC reveals a problem (M), this routine stops and the ATEC system will inform the controller of the results. If ATEC does not reveal a problem (M), the routine continues in the same manner as if no problem was found with manual level measurements.

Sheet 7 shows the information and direction received at the node from the sector (A). The node first checks to see if the information concerns a new fault or a fault which is currently being processed at the node (B). If so, and the information indicates that the problem has already been fault isolated (C), the node checks to see

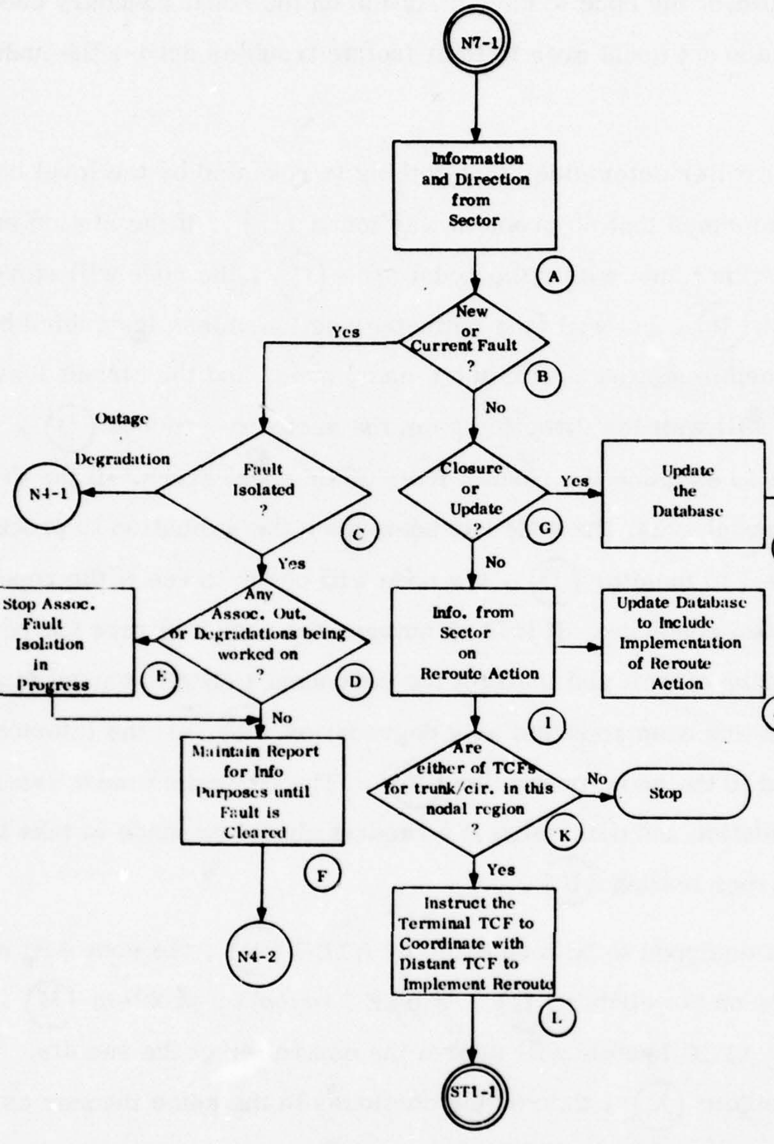


Figure 3.1-2. Nodal Level Functional Flowchart (Sheet 7 of 7)

if it is currently working on any associated problems (D). If so, the fault isolation is stopped and the information is maintained in the data base until the fault is cleared (F). If the node has an AUTODIN or AUTOVON switch within its area, the routine goes on to Sheet 4 to distribute the status information to the switch stations or the appropriate circuits. If the information concerns a new outage or degraded condition (C), the fault isolation routine on Sheet 4 is initiated.

If the information is not on a new or current fault (B), the node checks to see if it is an update or closure of a problem previously processed and currently being worked on at the station level (G). If it is, the node updates the status within its data base (H). The information distribution routine on Sheet 4 is again entered if the node has an AUTODIN or AUTOVON switch. The journaling function for closures is performed by the nodal area containing the station responsible for the manual fault isolation and is not performed here to eliminate duplication.

If the information is not an update (G), it is information about a reroute action being implemented by the sector (I). The node updates its data base to indicate the reroute plan is being implemented (J), and checks to see if either terminal TCF for the trunk or circuit is within its nodal area (K). If not, no further action is required of this node. If one or both of the terminal TCF's are within the nodal area, the node will direct the TCF(s) to coordinate on the implementation of the reroute (L). Upon implementing the reroute one TCF will send an update report to its node indicating that the reroute is established.

3.2 NODE DATA BASE DESCRIPTION

The following paragraphs describe the nodal level data base in terms of its structure, content and sizing requirements.

3.2.1 Structure

In support of the unified control effort at the node, nine data files were created. These files include node, station, link, trunk and CCSD masters, a measurement detail, fault detail, and a related fault detail. Figure 4.2-1 pictures graphically the data base structure. The linkages between data sets indicate that the detail data set records can be accessed through master record pointers. In this case, a chain of fault detail records can be retrieved for each node, responsible station, link, trunk, CCSD or fault ID. In addition, chains of related fault records can be read for each fault ID and a chain of measurement data records can be read for each CCSD or trunk.

3.2.2 Content

Tables 4.2-1 through 4.2-9 describe the content and format of each data file within the nodal level data base.

The connectivity for each station, link, trunk and circuit within the nodal area is provided in each of the respective master data files. A status summary or "degree of degradation" is also provided in these files. As faults are reported to the system, these status files are updated at every node containing the station link, trunk or circuit master record. The detailed fault record, generated from a trouble report, is added to the nodal data base of the responsible station. Any additional trouble reports on the same problem will cause related fault file records to be added to the data base and linked to the detailed fault record.

In the process of fault isolation, group pilot and channel level measurements will be made where possible. A separate file which is keyed on trunk or CCSD number has been set up to save the readings as they come back from the stations.

Finally, a directory of all stations under the node is provided in a node data file.

3.2.3 Sizing

The sizing estimates for the node data base are summarized in Table 4.2-10. The number of records within each data file (node, station, link, trunk, and CCSD masters) was determined using a group of sites in the European theater representative of a large nodal area. The estimates for the station, link, trunk and CCSD masters were then increased by fifty percent to allow for future expansion. The sites chosen for this sizing estimate were Donnersberg, Bann, Langerkopf, Ramstein, Pirmasens, Bad Kreuznach, Kaiserslautern, Zweibrucken, Lohnsfeld, Landstuhl and Baumholder.

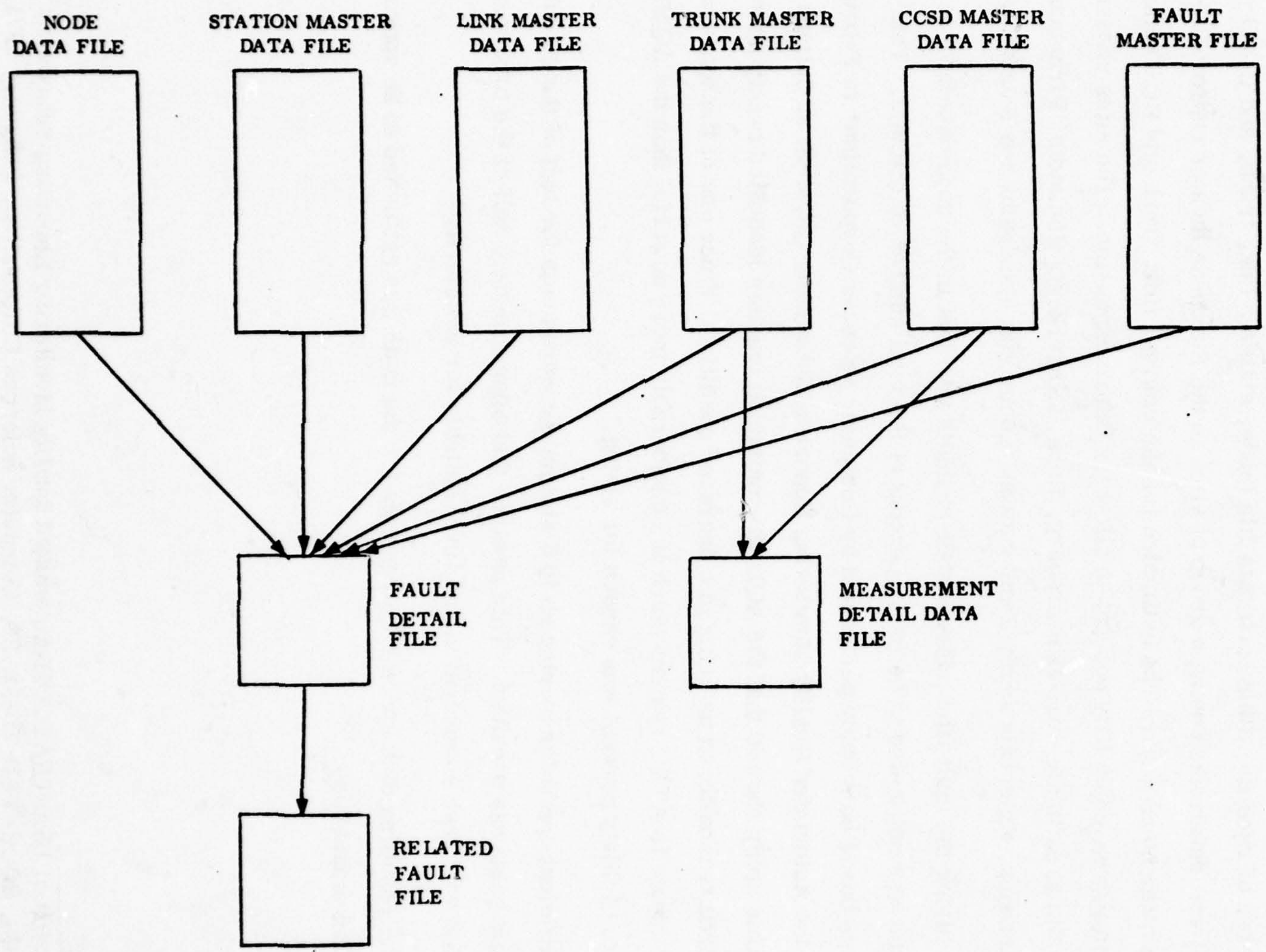
In sizing the fault files, the number of faults resident in the node data base at any given time was estimated to be thirty percent of the total number of circuits. This figure was based on a study performed by Computer Sciences Corporation* in February 1971 on the Automated Quality Monitoring Reporting Subsystem (AQMRS) at Coltano Italy. This study showed that the AQMRS monitoring function identified twenty percent of the circuits monitored as being in a degraded condition. Since one of the sources for fault inputs is ATEC system which is considerably more powerful than the AQMRS, the figure of thirty percent was chosen for sizing.

Sufficient space for storing up to 5 station measurements for half of the circuits in the data base was provided. This assures that approximately half of the total number of circuits will have a constant signal level suitable for monitoring.

The resulting disk space requirements for the node was estimated to be approximately 1.6 megabytes.

*Evaluation of USASTRATCOM Automated Quality Monitoring Reporting Subsystem (AQMRS), SCCC-TED-71-FR-22, Computer Sciences Corporation, February 1971.

NODE DATA BASE STRUCTURE



Note: The arrows indicate pointers within the Data File records allowing access to the detail or subordinate file records.

Figure 3.2-1. Node Data Base Structure

Table 3.2-1. Node Master Data File

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Node ID	Code uniquely identifying a given node.	ASCII	1
Sector ID	Sector to which the node is responsible.	ASCII	1
Station List	List of all stations responsible to the node (16 maximum).	ASCII	48
			Total = 50

Table 3.2-2. Station Master Data File

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Station ID	Name uniquely identifying the station. This field consists of a three character site code and a three character type code such as "DIN" for an AUTODIN station or "TCF" for a manual tech control facility.	ASCII	3
Node ID	Node to which the station is responsible.	ASCII	1
Link List	List of all links at the station (16 maximum).	ASCII	48
ATEC Indication	Code indicating whether or not the station is equipped with ATEC monitoring equipment.	ASCII	1
HAZCON Station Status Indication	Code indicating a HAZCON condition or station status.	ASCII	2
Fault Detail Pointer	Pointer to the first record in the Fault Detail Data File with the given station as the responsible station.	Integer	1
			TOTAL = 56

Table 3.2-3. Link Master Data File

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Link ID	Link Number	ASCII	3
Responsible Stations	Terminating stations for directions 1 and 2 of a given link.	ASCII	6
Trunk List	List of all DCS trunks on a given link (26 maximum).	ASCII	78
ATEC Indication	Code indicating whether or not the link is monitored by ATEC equipment.	ASCII	1
DOD (Direction 1)	Code indicating the degree of degradation in Direction 1 of the link.	ASCII	2
Isolation Flag (Direction 1)	Code indicating whether or not a fault in Direction 1 has been isolated.	ASCII	1
Fault ID (Direction 1)	Fault number assigned to a fault in Direction 1 of the link. Refer to the description of the Fault ID in the Fault Master Data File for the format of this field.	ASCII	3
DOD (Direction 2)	Code indicating the degree of degradation in Direction 2 of the link.	ASCII	2
Isolation Flag (Direction 2)	Code indicating whether or not a fault in Direction 2 has been isolated.	ASCII	1
Fault ID	Fault number assigned to a fault in direction 2 of the link. Refer to the description of the Fault ID in the Fault Master Data File for the format of this element.	ASCII	3
Fault Detail Pointer	Pointer to the first record in the Fault Detail Data File that is associated with the given link number.	Integer	1
			TOTAL = 101

Table 3.2-4. Trunk Master Data File (Sheet 1 of 2)

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Trunk ID	Trunk Number	ASCII	3
Responsible Stations	Terminating stations for directions 1 and 2 of a given trunk.	ASCII	6
VFCT CCSD	CCSD number (for VFCT trunks only).	ASCII	4
CCSD List	List of all CCSD's on a given trunk (32 maximum)	ASCII	128
ATEC Indication	Code indicating whether or not the trunk is monitored by ATEC equipment.	ASCII	1
Connectivity	Trunk connectivity list consisting of the nodes, stations, links, supergroups and groups that the trunk is routed over. The list will also indicate how the trunk appears at each station, i.e., VF termination, thru group, IF repeater, etc. In the example below, a trunk begins at LKF (node 01) manual tech control facility is thru-grouped at DON (node 2) and terminates at PMS. Node Type Direction Station Link SG G 01 V T LKFTCF M0671 02 3 02 G T DONTCF M0724 04 5 02 V R PMSTCF 00000 00 0	ASCII	180
Reroute ID (Preplanned)	Preplanned reroute trunk number. When alt-routing a trunk, the new connectivity can be found in the Trunk Master record for the trunk listed in this field.	ASCII	3
Reroute ID (Unplanned)	Rerouted trunk ID for those alt-routes employing a trunk other than the preplanned trunk. The new connectivity can be found in the Trunk Master record for the trunk listed in this field.	ASCII	3
Reroute Flag	Indication that the given trunk has been alt-routed.	ASCII	1

Table 3.2-4. Trunk Master Data File (Sheet 2 of 2)

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
DOD (Direction 1)	Code indicating the degree of degradation in Direction 1 of the trunk.	ASCII	2
Isolation Flag (Direction 1)	Code indicating whether or not a fault in Direction 1 has been isolated.	ASCII	1
Fault ID (Direction 1)	Fault number assigned to a fault in Direction 1 of the trunk. Refer to the description of the Fault ID in the Fault Master Data File for the format of this field.	ASCII	3
DOD (Direction 2)	Code indicating the degree of degradation in Direction 2 of the trunk.	ASCII	2
Isolation Flag (Direction 2)	Code indicating whether or not a fault in Direction 2 has been isolated.	ASCII	1
Fault ID (Direction 2)	Fault number assigned to a fault in Direction 2 of the trunk. Refer to the description of the Fault ID in the Fault Master Data File for the format of this field.	ASCII	3
Fault Detail Pointer	Pointer to the first record in the Fault Detail Data File that is associated with the given trunk number.	Integer	1
Measurement Detail Pointer	Pointer to the first record in the Measurement Detail File that is associated with the given trunk number.	Integer	1
			TOTAL = 343

Table 3.2-5. CCSD Master Data File (Sheet 1 of 2)

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
CCSD Number	Circuit Number	ASCII	4
Restoration Priority	Restoration priority of the given circuit.	ASCII	2
CCSD Type	Code indicating the traffic type on the circuit, i.e., VON IST, DIN IST, etc.	ASCII	2
VFCT Trunk Number	VFCT Trunk associated with the circuit (for VFCT CCSD's only)	ASCII	3
ATEC Indication	Code indicating whether or not the circuit is monitored by ATEC equipment.	ASCII	1
Connectivity	Circuit connectivity list consisting of the trunk and channel numbers over which the circuit is routed. In the example below, a circuit is routed over two trunks using Channel 10 of the first and channel 2 of the second. 44JMB1/10, 45CMA2/02	ASCII	150
Reroute ID (Preplanned)	Preplanned reroute circuit number. When alt-routing a circuit, the new connectivity can be found in the CCSD master record for the circuit listed in this field.	ASCII	4
Reroute ID (Unplanned)	Rerouted CCSD number for those alt-routes employing a CCSD other than the preplanned CCSD. The new connectivity can be found in the CCSD Master Record for the circuit listed in this field.	ASCII	4
Reroute Flag	Indication that the given circuit has been alt-routed.	ASCII	1
DOD (Direction 1)	Code indicating the degree of degradation in Direction 1 of the circuit.	ASCII	2

Table 3.2-5. CCSD Master Data File (Sheet 2 of 2)

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Isolation Flag (Direction 1)	Code indicating whether or not a fault in direction 1 has been isolated.	ASCII	1
Fault ID (Direction 1)	Fault number assigned to a fault in direction 1 of the circuit. Refer to the description of the Fault ID in the Fault Master Data File for the format of this field.	ASCII	3
DOD (Direction 2)	Code indicating the degree of degradation in Direction 2 of the circuit.	ASCII	2
Isolation Flag (Direction 2)	Code indicating whether or not a fault in Direction 2 has been isolated.	ASCII	1
Fault ID (Direction 2)	Fault number assigned to a fault in Direction 2 of the circuit. Refer to the description of the Fault ID in the Fault Master Data File for the format of this field.	ASCII	3
Fault Detail Pointer	Pointer to the first record in the Fault Detail Data File that is associated with the given circuit number.	Integer	1
Measurement Detail Pointer	Pointer to the first record in the Measurement Detail File that is associated with the given circuit number.	Integer	1
			TOTAL = 185

Table 3.2-6. Fault Master Data File

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Fault ID	Code uniquely identifying each fault reported within the system. The first two characters of this field will consist of the Node ID to which the problem was first reported. The last four characters will be the the next number in a sequential list of unassigned numbers.	ASCII	3
Link, Trunk or CCSD Number	The link, trunk or circuit on which the fault was reported.	ASCII	4
Fault Detail Pointer	Pointer to the record in the Fault Detail Data File that is associated with the given fault.	Integer	1
			TOTAL = 8

Table 3.2-7. Fault Detail Data File (Sheet 1 of 3)

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Fault ID	Fault number assigned to the trouble report initially entered on a link, trunk or circuit. This number will be the same as that contained in the Fault Master Data record.	ASCII	3
Reporting Station	Station where the initial link, trunk, or circuit trouble report was entered into the system.	ASCII	3
Fault Severity	Code indicating the type of fault, i.e., link, trunk or circuit.	ASCII	1
DTG of Report	Date-time group when the trouble report was generated.	ASCII	4
Link, Trunk or CCSD	The link, trunk or circuit number associated with the specified trouble report.	ASCII	4
Direction	Direction on which the fault was reported.	ASCII	1
RFO	Code indicating the reason for outage.	ASCII	2
ETR	Estimated time to repair the problem.	ASCII	4
In/Out Station	Code indicating whether the reporting station is actually reporting for another station.	ASCII	1
Pre-emption Flag	Flag indicating that fault isolation was stopped on this fault because it may have been caused by some higher order fault.	ASCII	1
DOD	Code indicating the degree of degradation reported on the link, trunk or CCSD.	ASCII	2
Isolation Flag	Code indicating whether or not the fault has been isolated.	ASCII	1

Table 3.2-7. Fault Detail Data File (Sheet 2 of 3)

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Alt-Route Flag	Code indicating whether or not the trunk or CCSD with the reported fault has been alt-routed.	ASCII	1
DTG of Alt-Route/ Restoral	Data-time group that the trunk or circuit was alt-routed and service restored to the user.	ASCII	4
DTG of Repair	Date-time group the problem was repaired and the fault closed.	ASCII	4
Responsible Station	Station responsible for closing the fault. This station is determined to be the terminating station for a given direction of a link, trunk, or circuit.	ASCII	3
Restoration Priority	Restoration priority of the circuit associated with the fault (if applicable).	ASCII	1
Remarks	Comments made by the operator when entering the trouble report.	ASCII	40
Related Fault Pointer	Pointer to the first record in the related fault file that is associated with the given fault ID.	Integer	1
Fault Detail Pointer	Pointer to the next record in the Fault Detail Data file that is associated with the given link number (if applicable).	Integer	1
Fault Detail Pointer	Pointer to the next record in the Fault detail data file that is associated with the given trunk number (if applicable).	Integer	1
Fault Detail Pointer	Pointer to the next record in the Fault Detail Data file that is associated with the given circuit number (if applicable).	Integer	1

Table 3.2-7. Fault Detail Data File (Sheet 3 of 3)

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Fault Detail Pointer	Pointer of the next record in the Fault Detail Data file that contains a pre-empted lower order fault.	Integer	1
Fault Detail Pointer	Pointer to the next record in the Fault Detail Data file that is associated with the given responsible station.	Integer	1
			TOTAL = 86

Table 3.2-8. Related Fault File

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Fault ID	Fault ID assigned to a trouble report on a given link, trunk or circuit. Should more than one report be sent to the node, they will be assigned the same Fault ID as the original report and stored in the Related Fault Detail Data File.	ASCII	3
Link, Trunk or CCSD	Link, trunk or circuit associated with the given fault.	ASCII	4
DTG of Report	Date-time group of trouble report.	ASCII	4
Reporting Station	Station reporting the fault.	ASCII	3
Related Fault Pointer	Pointer to the next record in the Related Fault File that is associated with the same Fault ID.	Integer	1
			TOTAL = 15

Table 3.2-9. Measurement Detail Data File

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Station ID	Station at which the measurement was made	ASCII	3
Direction	Direction that measurement was made	ASCII	1
Measurement Value	Value of the measurement made	Integer	1
Measurement Detail Pointer	Pointer to the next record in the measurement detail data file that is associated with the given circuit or trunk	Integer	1
			Total = 6

Table 3.2-10. Nodal Level Data Base Sizing

DATA FILE NAME	RECORD SIZE (WORDS)	NUMBER OF RECORDS	FILE SIZE WORDS	FILE SIZE BYTES
NODE MASTER	50	1	50	100
STATION MASTER	56	16	896	1,792
LINK MASTER	101	45	4,545	9,090
TRUNK MASTER	343	330	113,190	226,380
CCSD MASTER	185	3,000	555,000	1,110,000
FAULT MASTER	8	900	7,200	14,400
FAULT DETAIL	86	900	77,400	154,800
RELATED FAULT DETAIL	15	900	12,500	27,000
MEASUREMENT DETAIL	6	7,200	43,200	86,400
TOTAL			814,981	1,629,962

3.3 SOFTWARE CONSIDERATIONS FOR THE NODE

A preliminary software design for the Node has been performed using the THREADS design methodology. This process is described in detail in Section 1.4. In the following subsections a detailed software design for the Node level of unified control is presented in terms of the THREADS (identified during the design effort) to support the functional capabilities discussed in Section 3.1.

For each nodal function a THREAD flow diagram which describes the processing steps required in accomplishing the function and the routines supporting each processing step is presented. A sizing analysis is then provided which addresses individual routine size requirements as well as overall Node processing system size requirements including estimates of lines of code and memory occupancy. Processor memory requirements are then addressed including support software, resident data structures and overlay techniques. A parametric processing load analysis is provided which shows processor and disk load requirements for the Node as a function of various system event occurrence rates. Finally, the general characteristics of processor support software as they pertain to the Nodal level of unified control are discussed.

3.3.1 Node Software Design

The following paragraphs present a software system design for the Node in terms of 55 Node level THREADS. These THREADS are derived from the Node level requirements presented in Section 3.1, where each THREAD supports a specific functional requirement. The THREADS are first presented in a hierarchical structure which shows all software capabilities available to each functional element of unified control at the Node level. Each THREAD is additionally described in a THREAD flow diagram which shows the discrete processing requirements and individual routines necessary to accomplish the prescribed function. Finally, all routines identified in the THREAD flow diagrams are summarized in a hierarchical computer program structure showing the various levels of control within the applications software system.

3.3.1.1 Node THREADS

Figure 3.3-1 summarizes the THREADS which comprise the Node level of unified control. The figure shows a hierarchy of THREADS supporting each operational element serviced by the Node including the Nodal Controller, Sector, Station Controller, ATEC, AUTOVON, and AUTODIN Switches.

The top level of the hierarchy performs I/O and preliminary message processing functions. The software represented by these THREADS performs line handling, buffer management, and task scheduling activities. The stimulus to these THREADS is generally an interrupt or other condition indicating a call for input or output service, while the response is a completed I/O operation with appropriate subsequent processing scheduled. Each subsequent processing task is supported by a distinct THREAD located on the second level of the hierarchy. The scheduling activities performed by the top level THREADS serve as the stimulii to the various second level THREADS.

The second level THREADS are grouped into six subtrees corresponding to the six sources of external stimulus to the Node. These groups are mapped to the top level THREAD they support by the connectors A through F on the first sheet of the figure. To examine the support available to a given Nodal element it is necessary only to inspect the corresponding subtree for that element.

The third level of the THREAD hierarchy contains only two THREADS. These THREADS deal exclusively with fault entry processing in support of the Station Controller, ATEC, AUTOVON and AUTODIN elements, and therefore require an additional hierarchical level in order to be accessible to the second level THREADS for these elements. This commonality of detailed fault entry processing is possible since each of the elements enumerated above is considered an equally valid source of fault data to the system. Further, all faults carried by the system are structured and accessed in a consistent manner regardless of the source of the fault data. The minor syntactical and content variations in fault data supplied by the various sources are accommodated in the second level fault acceptance THREADS which serve as pre-processors to the detailed fault entry processing THREADS on the third level.

The THREADS contained in Figure 3.3-1 are presented in an abbreviated format. In the next paragraph each THREAD will be expanded into a flow diagram in order to show the detailed processing requirements and associated software requirements to accomplish the function supported by the THREAD.

3.3.1.2 THREAD Flow Diagrams

Figures 3.3-3 through 3.3-9 show the detailed flow diagrams for the Node level THREADS. Each figure contains the diagrams for all THREADS which support a given Nodal element or common functional requirement. Table 3.3-1 summarizes the contents of these figures.

The basic format of the flow diagram is shown in Figure 3.3-2. The stimulus and response information will be the same as indicated in the abbreviated formats used in the THREAD hierarchy. However, while the processing information is summarized in the abbreviated format, it is expanded into a series of more precise steps in the flow diagram. Each step also lists the computer programs necessary to support the indicated processing.

The supervisory level and I/O diagrams are shown in Figure 3.3-3. These THREADS divide into two basic types. The first six THREADS address input processing of data from each Unified Control element which communicates directly with the Node. In addition to input handling functions they perform supervisory scheduling functions based on the message types that are received. The remaining three THREADS perform communications output handling for the ATEC, AUTOVON and Sector interfaces.

Figures 3.3-4 and 3.3-6 show the THREAD diagrams which provide support to the Node and Station Controller positions respectively. Many of the requests that can be made from these positions are identical and utilize common software. Among the types of data that may be requested at these positions are media status, detailed fault record information, connectivity, journal contents, and summaries of outstanding faults.

Figure 3.3-5 shows the Sector handling software. The majority of the messages received from the Sector are of three general types: responses to requests for data from other points in the unified control system, requests to supply data to other points in the system, and fault related broadcast messages. Messages are also provided for issuing control directives including fault responsibility assignment, performance of configuration updates and reroute implementation. Several additional messages are provided for maintaining data base integrity including connectivity modification and reroute confirmation messages. In these two cases, the data base is not updated until confirmation of the modification has been made by the responsible element.

Figure 3.3-7 shows the preprocessing THREADS which accept ATEC inputs. The first THREAD accepts fault notification messages and generates detailed fault records from the message data, and schedules further processing. This THREAD will also inform ATEC as to the isolation status of the reported fault in order to avert unnecessary ATEC fault isolation activities. The second THREAD accepts responses to status request messages and routes them to the requesting position.

The AUTOVON and AUTODIN switch preprocessing THREADS are shown in Figure 3.3-8. Both of these THREADS generate detailed fault records from the received message data and schedule the records for detailed fault entry processing.

Figure 3.3-9 shows the detailed fault entry processing THREADS. These THREADS perform similar processing functions but derive different responses. The first THREAD processes new faults which occur on media where no higher order faults have been reported. The fault is therefore assumed to be a legitimate problem on the CCSD, trunk or link as reported. The second THREAD processes faults which may be due to higher order outages or degradations. In both cases, the Media and Fault Files are updated to reflect the report. If the fault is determined to be unrelated to existing higher order faults, a check is made to determine if there are any lower order faults currently on record which may be related to the newly reported fault. All such faults are flagged, linked as possibly related to the new fault and,

where local isolation activities are taking place, such activities are suspended until resolution of the new fault. A fault notification broadcast message on the new fault is then prepared and forwarded to the Sector.

If, on the other hand, the new fault is found to be possibly related to an existing higher order fault through a comparison of relative fault severities and degrees of degradation, the data pertaining to the new fault is forwarded to the position responsible for the existing higher order fault to aid that position with fault isolation. Additionally, appropriate local notifications are generated and displayed.

In the next paragraph, all of the computer programs which are identified in Figures 3.3-3 through 3.3-9 are presented in a computer program hierarchy in order to show the relationships of the various routines and to summarize the applications software system for the Node.

3.3.1.3 Computer Program Hierarchy

All of the routines which are identified in the Node level THREADS have been structured into a six-level program hierarchy. In determining the appropriate level for a given routine, two guidelines are followed. First, a given routine may call only those routines which reside at lower hierarchical levels. The application of this rule ensures that the levels of the hierarchy indicate the various levels of control within the software system. Second, each level of the hierarchy should be functionally homogeneous. That is, routines which perform similar functions should be grouped at a given hierarchical level.

Figure 3.3-10 shows the program hierarchy for the Node level of unified control.

The top level of the hierarchy contains the NODE SUPERVISOR which controls execution of all scheduled events in the software system.

The second level contains the interrupt driven I/O drivers and a series of message processors. Each message processor controls the support activities for one of the major input sources at the node. In general, these routines supervise message decoding/validation and perform overlay retrieval.

The third level of the hierarchy contains the routines responsible for performing major operational functions. Such functions include processing individual controller requests, and individual sector message types.

The fourth level provides significant support functions to the various third level routines. For example, the third level NODE CONNECTIVITY DISPLAY PROCESSOR depends heavily on the four connectivity RETRIEVAL routines on this level. This amount of functional support minimizes duplication of software between the various operational function routines on the third level. In addition, it provides a level of insulation between the functionally oriented routines in the upper levels and the various data base structures employed in the lower levels of the hierarchy.

The fifth level consists largely of file managers for the various components of the data base. These file managers rely largely on the sixth level generic data base management support routines FIND, GET, CREATE, DELETE and MODIFY for access to the various files. Additional system support activities supplied on the sixth level include error processing, message type decoding and I/O buffer management.

3.3.2 Software Sizing

The following two paragraphs present a software sizing analysis for the Node. In the first paragraph, each routine identified during the design effort is addressed in terms of estimated lines of code and program and data occupancy requirements. The second paragraph then presents processor memory requirements based on a two-level overlay structure.

3.3.2.1 Program Sizing

The sizing of the programs presented in this paragraph is based on an estimation of the number of lines of HOL code required to implement each routine in the Node program hierarchy (Paragraph 3.3.1.3), plus additional memory required to accommodate data for each routine. This sizing includes applications software and operating system enhancements only and assumes that the host computer supplies support software capabilities as described in Paragraph 3.3.4.

Table 3.3-2 summarizes the program sizing for the Node. The program occupancy for each routine is based on an expansion factor of 15 bytes of storage for each line of HOL. This ratio is typical of 16-bit word length machines using currently available HOL compilers. Further justification of this expansion ratio is provided in Section 1.4. Where applicable, the data occupancy for each routine includes buffer and table space requirements. Without the use of overlays, the total memory requirement for the Node applications software is 236K bytes.

3.3.2.2 Processor Memory Requirements

The software system described in Section 3.3.1 is functionally partitionable and is susceptible to incorporation into an overlay structure. The use of overlays, where on-line secondary storage capabilities are available, minimizes processor memory requirements by retaining low demand software in secondary storage.

An overlay structure for the Node software was developed by dividing the routines contained in the Node program hierarchy into three categories: resident, element support and functional support.

The resident routines are high demand routines which support supervisor/control of all processing functions. Such routines as the NODE SUPERVISOR, the I/O drivers, the generic data base access routines and the destination processor are considered in this category since they are used to support all nodal elements and most of the functional routines. Table 3.3-3 summarizes the resident routines for the Node. These routines require 55,350 bytes of memory.

The routines which compose the support overlays are also summarized in Table 3.3-3 according to the nodal element which they support. The positions and their respective support sizes are summarized below:

NODAL CONTROLLER SUPPORT	32,925 bytes
SECTOR SUPPORT	34,050 bytes
STATION CONTROLLER SUPPORT	30,675 bytes
ATEC	33,300 bytes
AUTODIN REPORT PROCESSOR	31,050 bytes
AUTOVON MODULE	31,800 bytes

The routines which are used for supporting the Nodal Controller, the Station Controller and the Sector are defined to be those routines that would be needed by any of the functional routines supported by the given element. The routines which are part of the ATEC, AUTODIN, and AUTOVON overlays include both the support and functional routines except for the detailed fault processing routines.

The routines comprising the functional overlays for the Nodal Controller, Sector and the Station Controller are summarized in Table 3.3-4. Depending on the function to be performed, only one of these overlays would be in memory at any time.

In order to determine the amount of memory required at the node for applications software, it is necessary to add the memory requirements for the resident routines, support overlay routines and the largest functional overlay module for each nodal element. Table 3.3-5 shows that the largest memory requirement occurs for processing Sector input. In this case the applications software requires 103,650 bytes of main memory.

In addition to the applications software requirements, the processor memory must accommodate the resident portion of a disk based operating system. Based upon currently available real-time operating system software, a residency requirement for an operating system providing the support outlined in Section 3.3.4 is 12,000 bytes. This does not include occupancy within the operating system for the I/O drivers and buffer areas which were sized as part of the applications software. The total node memory requirements is now determined to be 116K bytes.

3.3.3 Node Processing Load

A worst case sustained load analysis is presented in this paragraph. Both processor and disk utilizations are considered because of the large amount of data base access activity required to support unified control functions. The utilizations are parametrically derived and presented in a series of curves which show utilization as a function of the rate of station level fault entry and sector level fault notification.

Table 3.3-6 summarizes the set of worst case algorithms on which the load analysis is based. Each algorithm is analyzed for the number of assembly language instructions executed and the number of disk accesses performed for a single execution of the algorithm. The flowcharts and detailed analysis of these algorithms are contained in Appendix A to this report.

Algorithm N1 performs processing of fault notification broadcast messages received from the sector. Algorithms N2, N3, N4, and N5 perform fault entry preprocessing for the various sources of fault data at the station level. Algorithm N6 accepts the preprocessed fault data and performs detailed fault entry processing. This algorithm is executed once for each execution of algorithms N2 through N5. Algorithm N7 is the worst case display request that can be made from a controller position. This algorithm will be used later in this paragraph to establish average and worst case operator response times.

Table 3.3-7 shows the derivation of the worst case I/O support load. For each element interfaced at the node the maximum aggregate bandwidth is computed in terms of the number of assembly level instructions required per second to effect the I/O transfers. For the worst case it is assumed that data will be passed a character at a time on the processor I/O bus. From this table the I/O load at the node is 6,900 instructions/sec.

Figure 3.3-11 presents the derivation of the processing load at the Node.

From Equation (1) it is seen that the total processing load is the sum of the loads supporting station level fault entry (P_{FAULT}), sector level fault notification (P_{SECTOR}), cycle stealing due to disk activity (P_{DISK}) and communications I/O ($P_{I/O}$). Equation (2) shows that the fault entry and fault notification processing loads are the products of the single occurrence loads and occurrence rates. Equations (3) and (4) show the computation of the single occurrence loads for station level fault entry and sector level fault notification respectively. Since the sustained load will be computed for a one minute interval, a time conversion factor must be included to find the effective

average second load. Equation (5) accounts for memory cycle stealing due to the disk DMA activity. An average disk access size of one 256 word block is assumed. Equation (6) shows the communications I/O load. The worst case I/O load as presented in Table 3.3-7 is assumed. By rewriting Equation (2), Equation (7) now shows the node processing load as a function of the rate of fault entry and fault notification. This equation is plotted in Figure 3.3-12 for values of R_{FAULT} from 0 to 30 and R_{SECTOR} from 0 to 20. Because the load is distributed evenly over the fault occurrence interval of one minute, the load on the processor is relatively low.

Figure 3.3-13 shows the derivation of the disk load at the Node. Equation (1) shows that the total disk load is the sum of the disk loads supporting fault entry and sector fault notification processing. These quantities are a function of the rate of fault related event occurrence as shown in Equation (2). Equation (5) shows the total disk load as a function of these occurrence rates. Figure 3.3-14 plots D_N as a function of R_{FAULT} and R_{SECTOR}. The 100 percent utilization line for a typical moving head disk with sufficient capacity to accommodate the Node data base is also indicated on this figure. This utilization threshold is based on a 50 millisecond average access time.

It is seen from the projected processor and disk loads that the nature of unified control processing is highly I/O bound. Disk utilization is therefore the critical factor in accommodating a worst case situation.

Consider the case where the following unique faults are reported from the station level at a single Node within a one minute period:

ATEC	5
AUTOVON	2
AUTODIN	2
STATIONS	10 (one per station)
	19

Reading the disk load from Figure 3.3-14 it can be seen that as many as 20 fault notifications can be received from the Sector during this same one minute interval before the disk load approaches saturation. If the utilization of the disk were to reach 100 percent, a degradation in system response time would result for as long as the saturating conditions persisted. In view of the nature of the data under consideration and the operator limiting speeds for entry of a large portion of the data, this worst case could not be sustained for a significant length of time.

The average load on the Node is considerably less than cited above since the average daily fault occurrence rate for the entire European DCS, assuming automated monitoring capability, is on the order of 20 percent of all circuits.

Assuming the largest node to have jurisdiction over 2000 circuits, the average fault occurrence rate at this node is 400 faults/day. Further assume that half of these faults occur during normal working hours. The average number of faults during this period is then 25 faults/hour or less than one-half fault/minute.

Algorithm N7 can be used to determine operator response times as a function of the relative load on the Node processor and disk. The algorithm requires that 18,012 instructions and 16 disk accesses be performed. The response time will be dominated by disk access time. The disk activity, assuming no contention for disk resources would require 800 milliseconds (16 accesses @ 50 milliseconds/access).

Assuming a relatively slow processing capability (8 microsecond average instruction time) the processing would require 144 milliseconds (no contention).

The total time until the connectivity request processing is completed and the data is ready for display is then .944 seconds when no other activity is ongoing.

Assuming that the Node is processing 20 station level faults and 20 sector level fault notifications the response time for this request then degrades to 2.01 seconds (1.75 seconds total for disk, .256 seconds for processing).

3.3.4 Support Software

The support software required for the unified control system can be separated into operational software and development software. As part of the operational software, a disk-oriented operating system is needed. The operating system should include such things as an overlay loader/linker, a task scheduler capable of swapping programs as needed and a capable file manager to control all of the programs and files which are located on disk.

Diagnostic software should also be provided to help detect and isolate system problems such as malfunctions in the processor and I/O controller hardware or in the peripherals.

Although the software was sized to include some general and simple data base functions, it would be possible to use a data base management system instead if one was available. The DBMS features should include: a database description to define files, records, and inter-record relationships; a database manipulation language to create, delete and modify records; some basic utility support routines to load/unload the database files and initialize the database. Currently there are two types of database structures available for minicomputers. They can be separated into network models (i.e., TOTAL, HP's IMAGE) and CODASYL models (i.e., DEC's DBMS-11).

Vendor supplied database management software for minicomputers is a relatively new development. Of the lower powered network structured management systems, TOTAL, an adaptable package provided by CINCOM, has been the most widely installed system by minicomputer manufacturers including Varian, Harris, and Interdata. Other manufacturers are currently in various stages of negotiation with CINCOM to provide TOTAL.

The CODASYL based database systems are gaining popularity and although not currently available on many minicomputer systems should be available from increasing numbers of manufacturers in the future.

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UNIFIED NETWORK/TRAFFIC TRANSMISSION MEDIA CONTROL.(U)
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UNCLASSIFIED SBIE -AD-E100 234 NL

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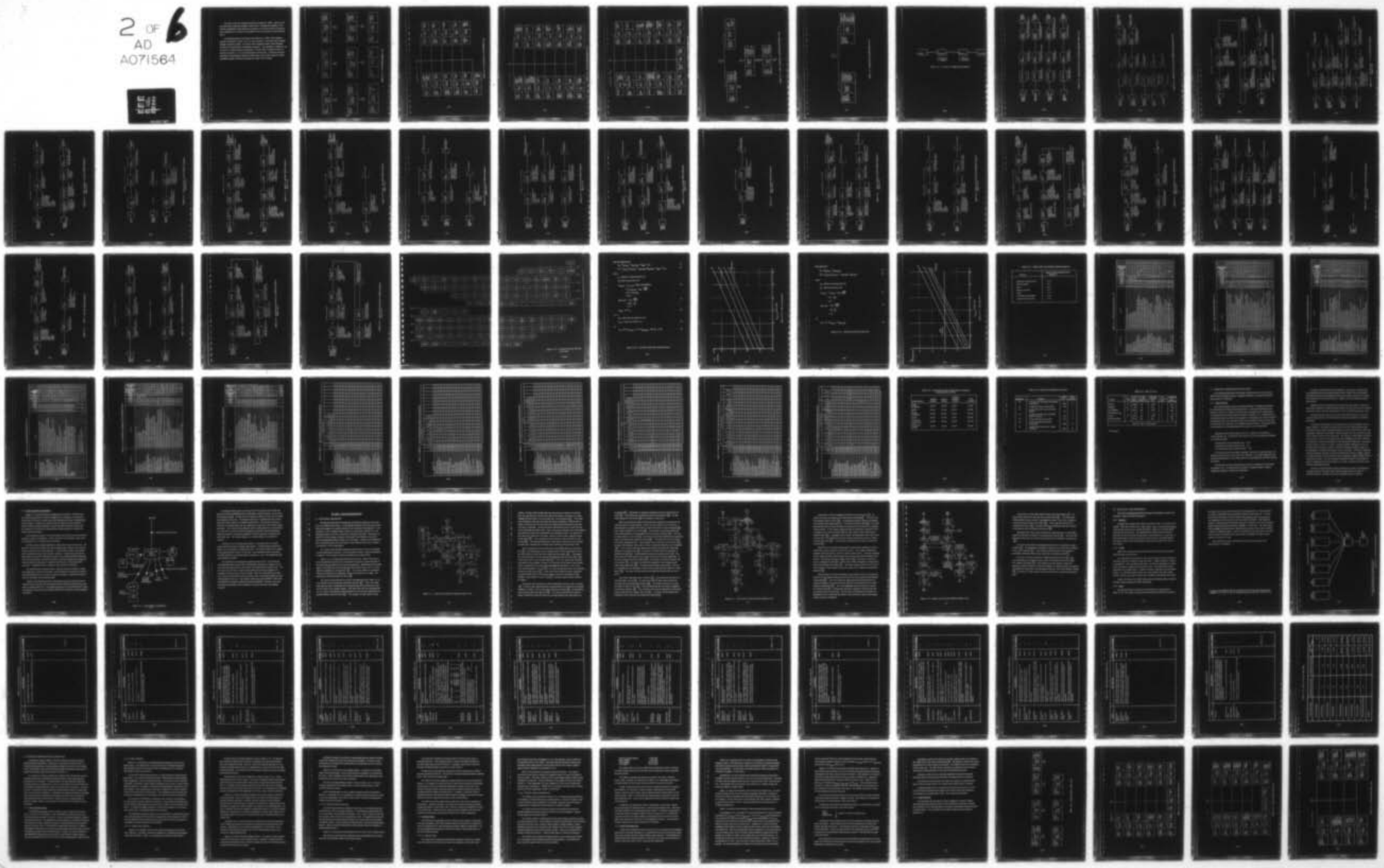

2 OF 6

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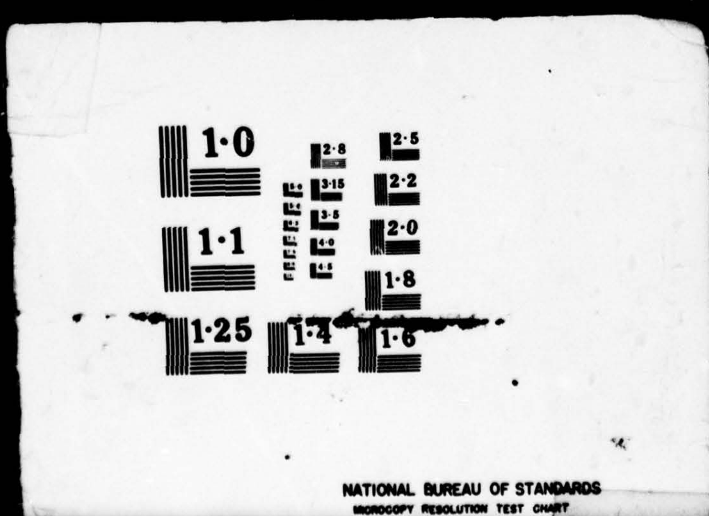


The nature of the data management functions required in unified control is such that either type of data base manager could be used. Although the availability of the CODASYL capabilities would reduce the complexity of the various data file structures, such capabilities are not likely to be available on low end processors in the immediate future.

For the development of the system such software as a higher-order language compiler (FORTRAN, COBOL, PL-I, etc.),an assembler, a text editor and a symbolic debugger should be included. The higher-order language compiler and the debugger are used in the development of applications programs. The assembler is needed for any I/O driver or system software modifications. The text editor is needed to allow for program corrections in an on-line developmental environment. The above-mentioned operational and development software would provide a basic system with the minimal capabilities needed to develop and operate the unified control system.

NODE THREADS

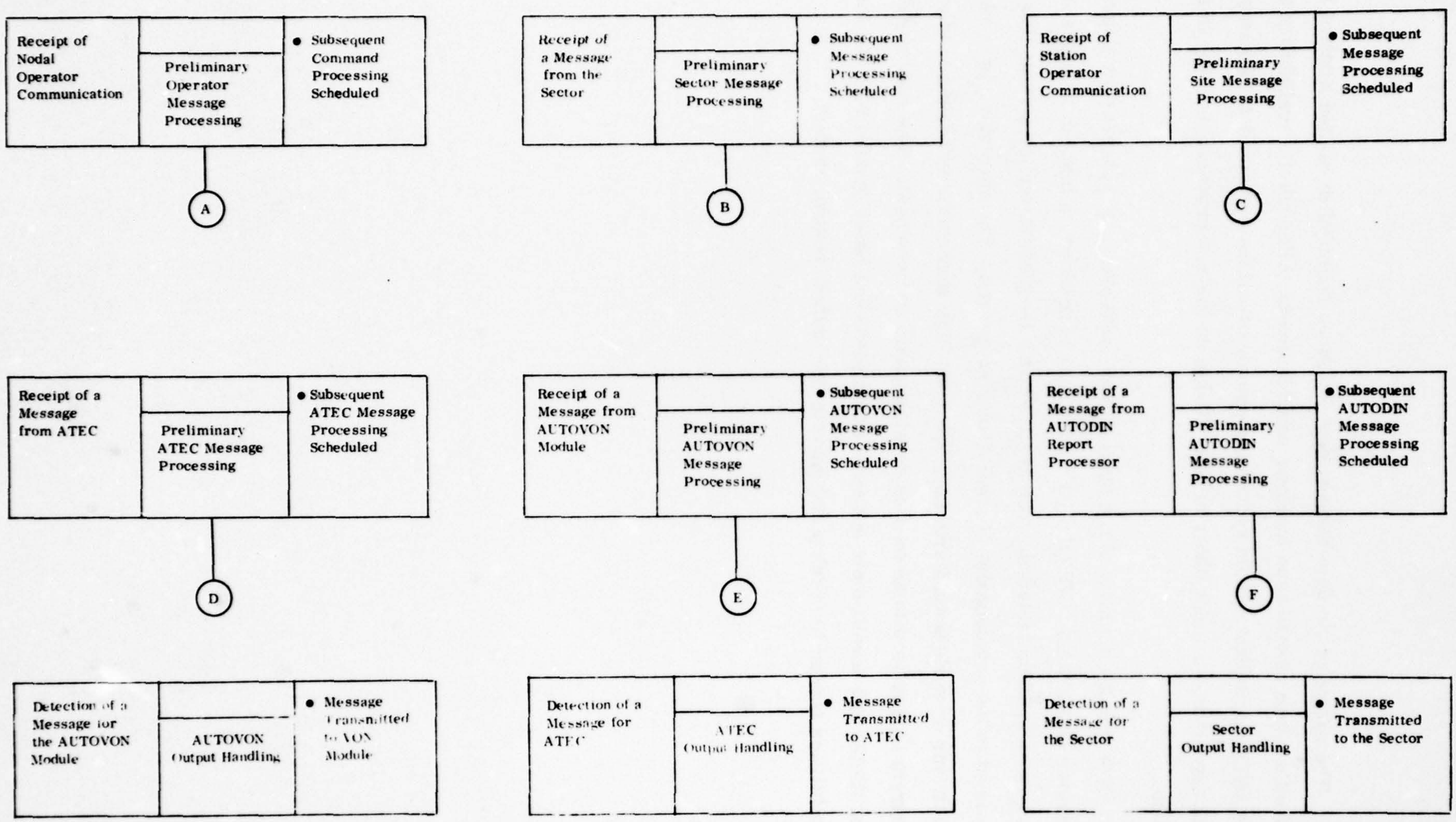


Figure 3.3-1. Node THREADS (Sheet 1 of 6)

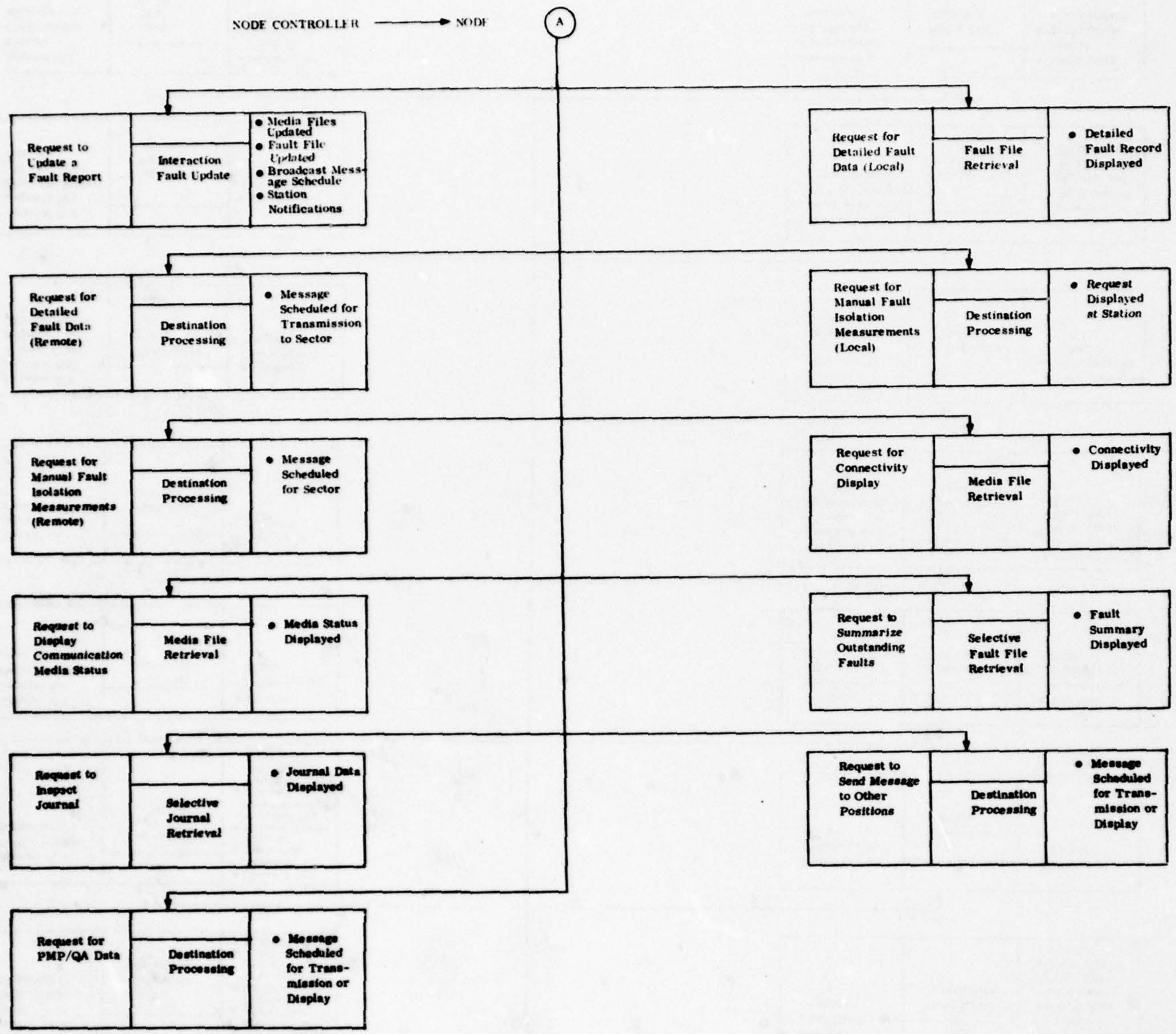


Figure 3.3-1. Node Controller → Node (Sheet 2 of 6)

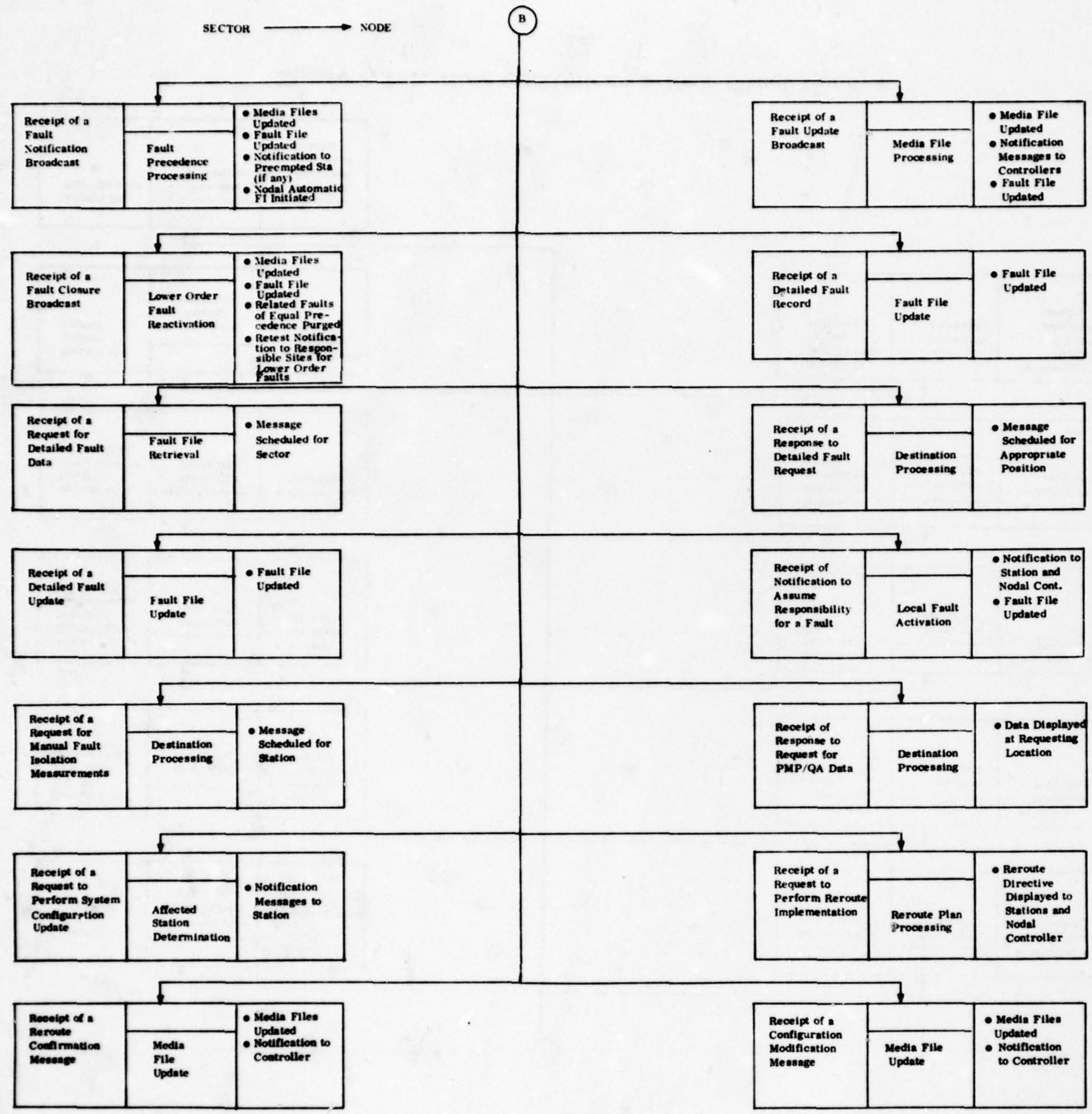


Figure 3.3-1. Sector → Node (Sheet 3 of 6)

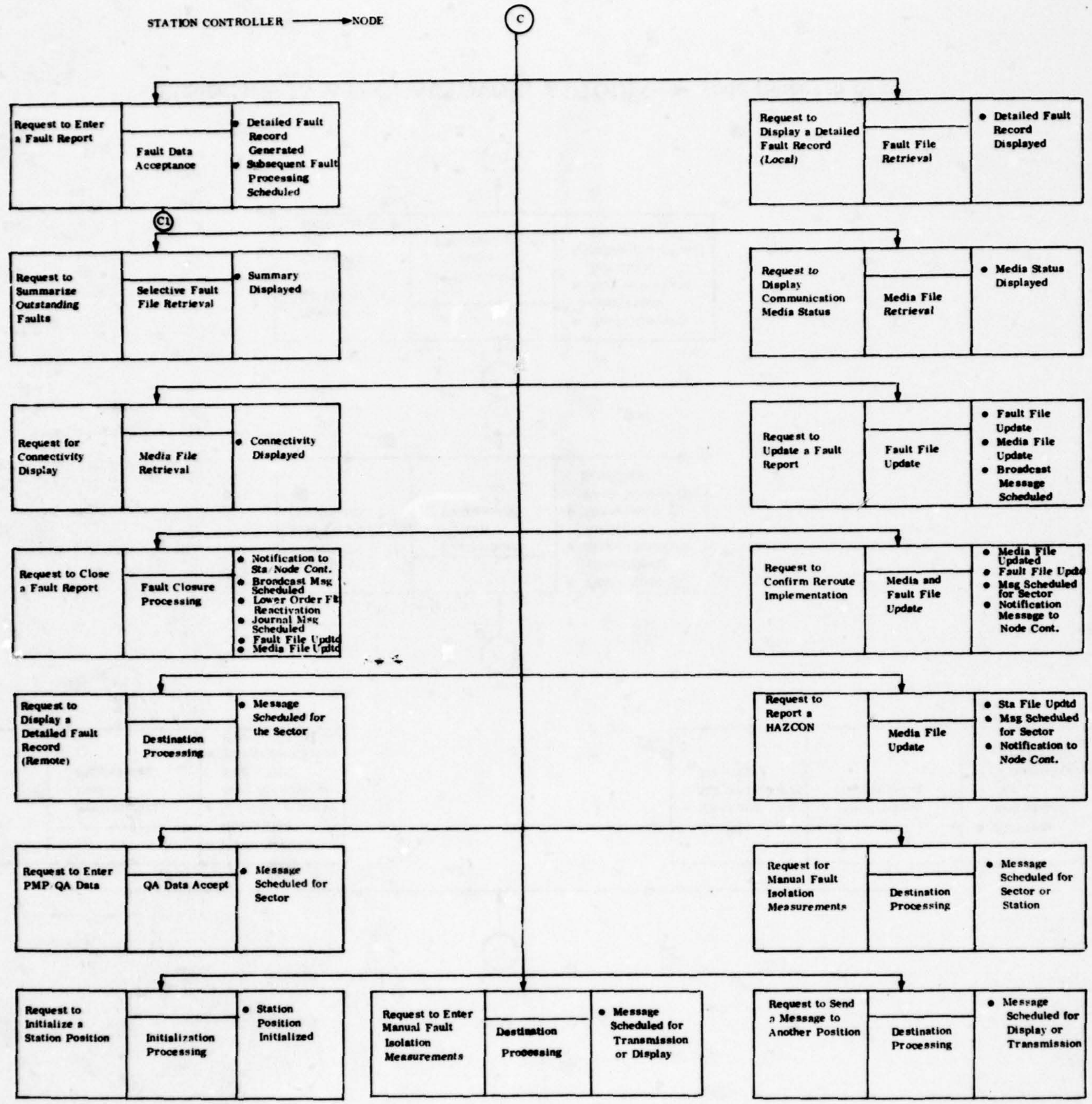


Figure 3.3-1. Station Controller → Node (Sheet 4 of 6)

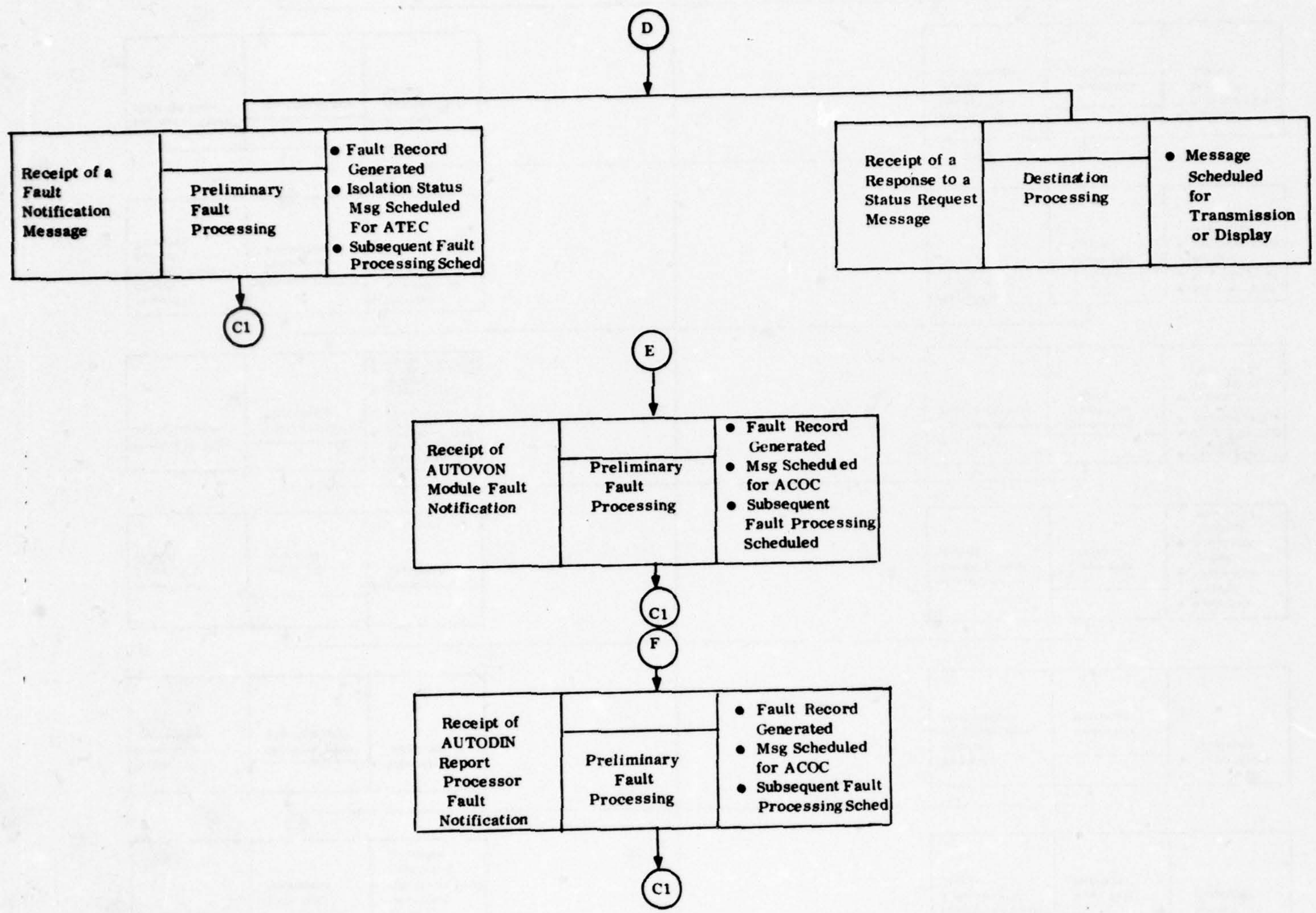


Figure 3.3-1. ATEC, AUTOVON, AUTODIN→Node (Sheet 5 of 6)

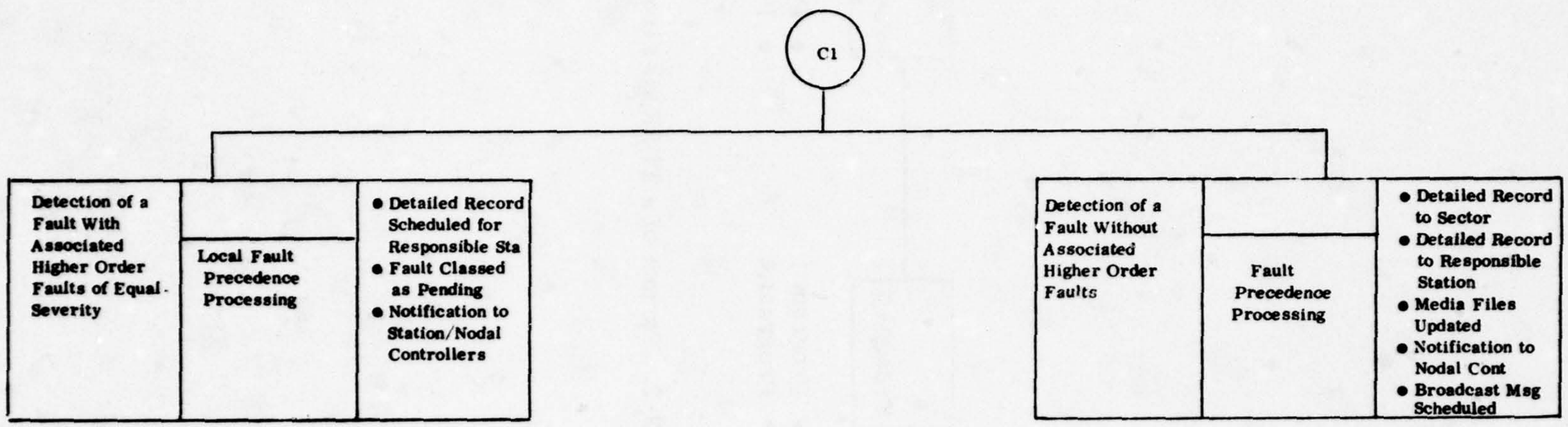


Figure 3.3-1. Fault Entry Processing (Sheet 6 of 6)

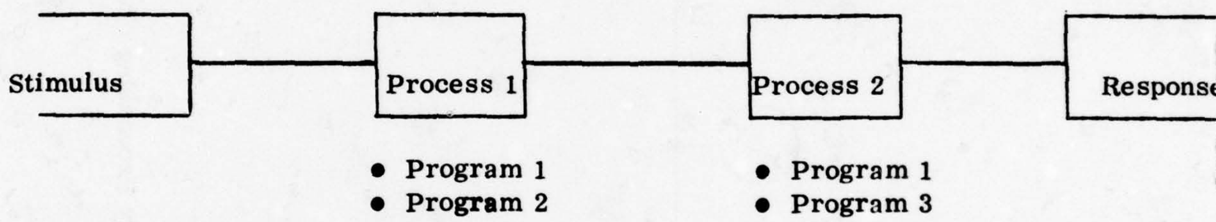


Figure 3.3-2. Format of a THREAD Flow Diagram

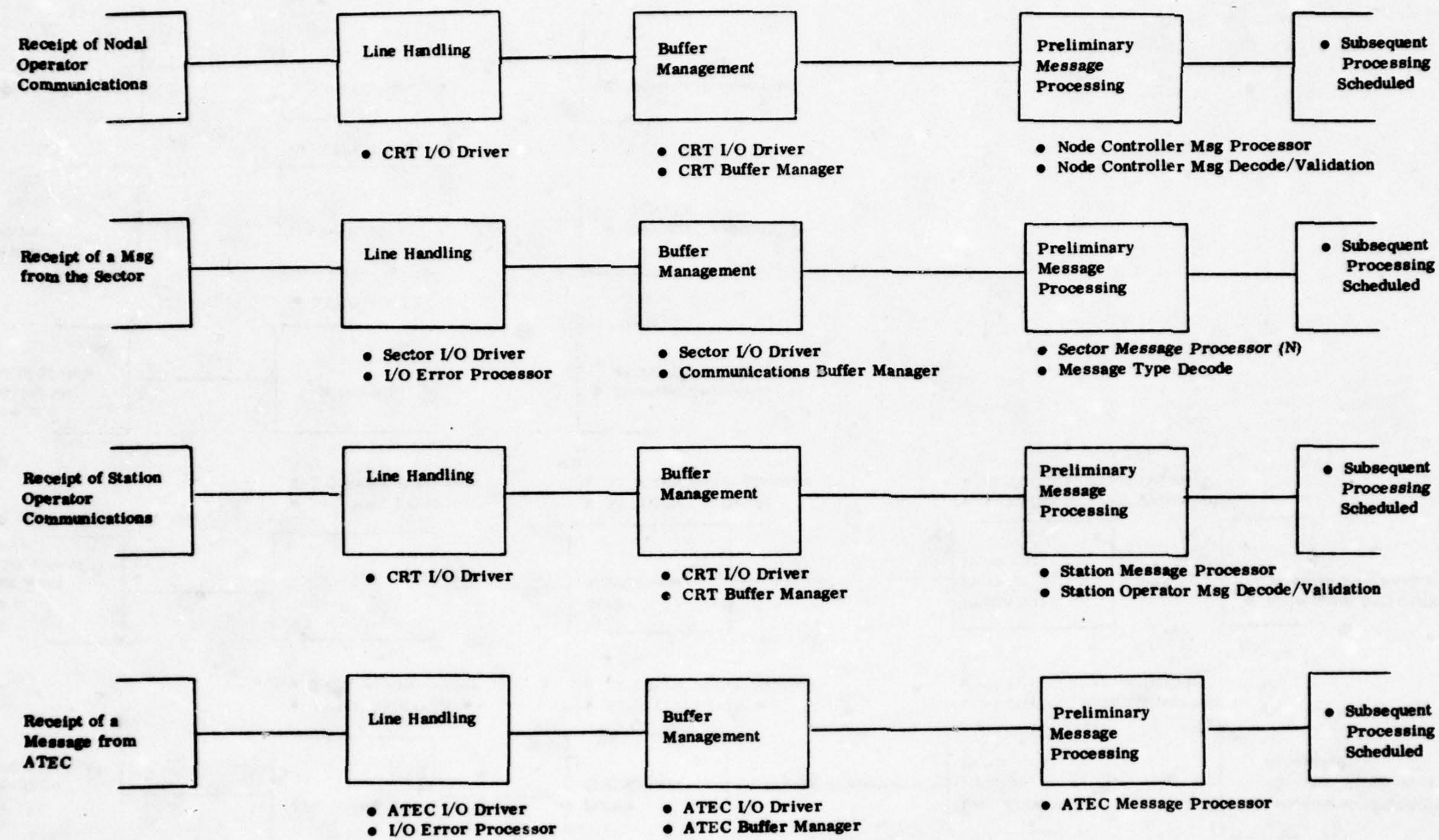


Figure 3.3-3. Supervisory and I/O Level THREAD Diagrams (Sheet 1 of 2)

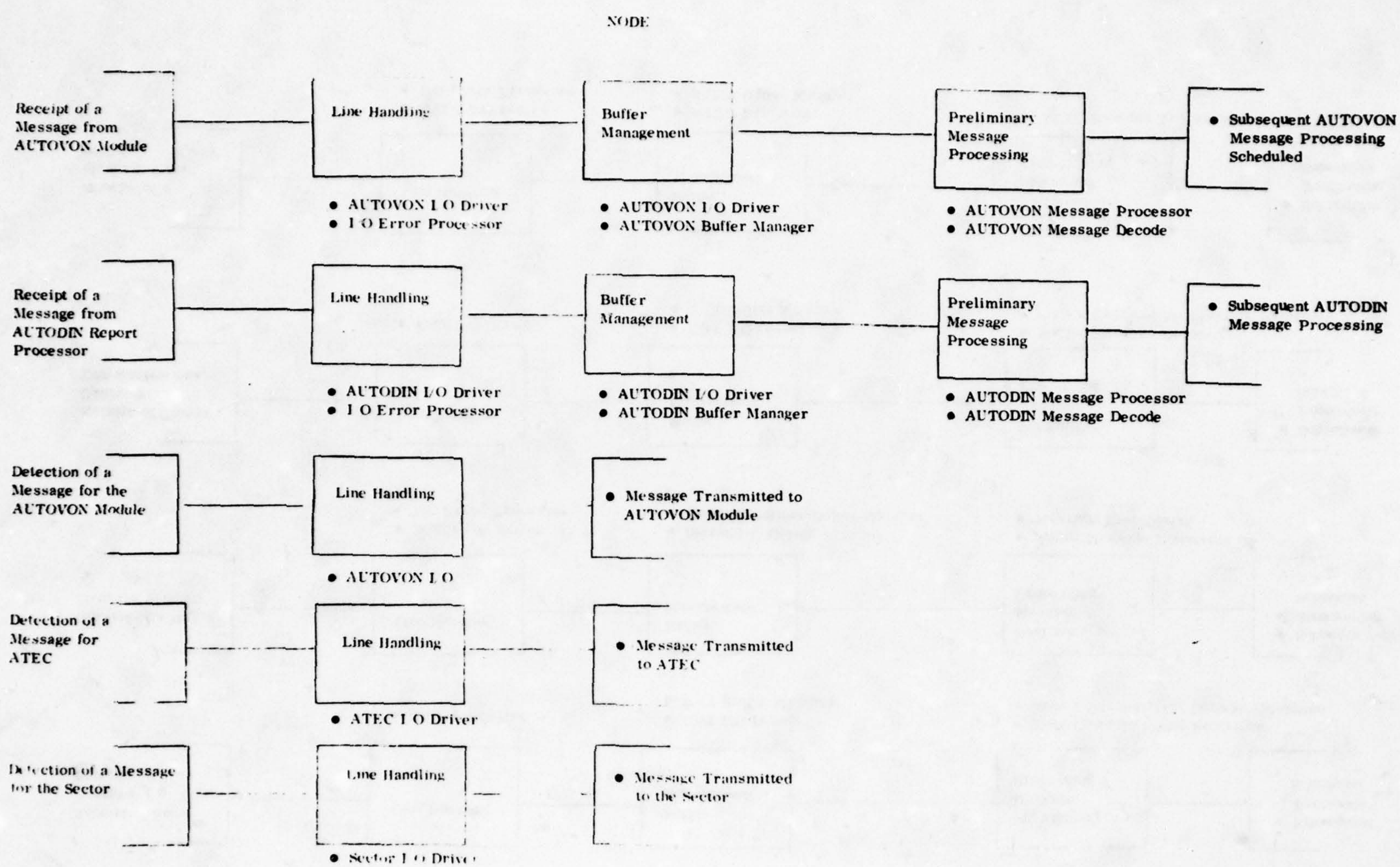


Figure 3.3-3. Supervisory and I/O Level THREAD Diagrams (Sheet 2 of 2)

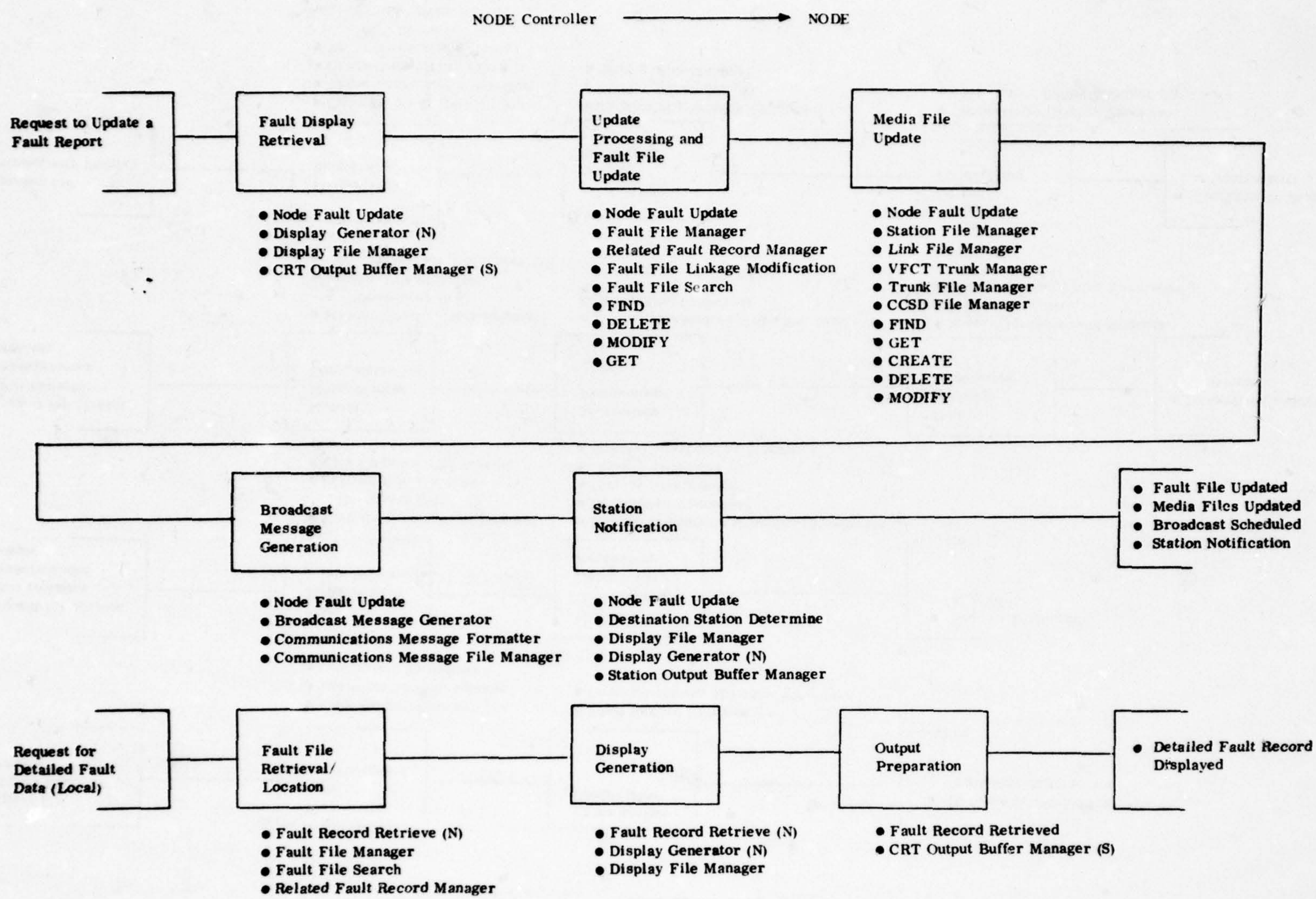


Figure 3.3-4. Node Controller ——► Node THREAD Diagrams
(Sheet 1 of 4)

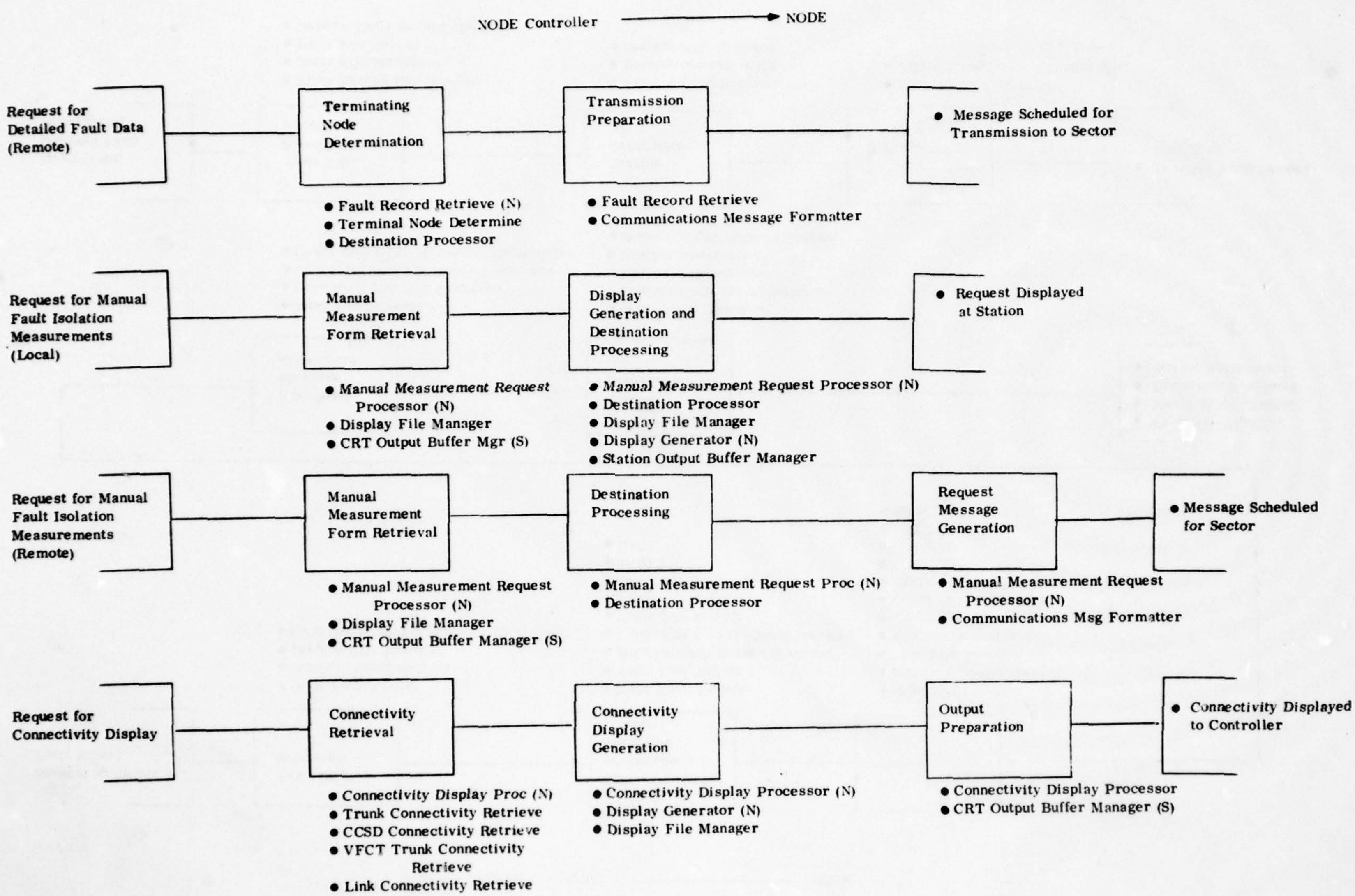


Figure 3.3-4. Node Controller → Node THREAD Diagrams (Sheet 2 of 4)

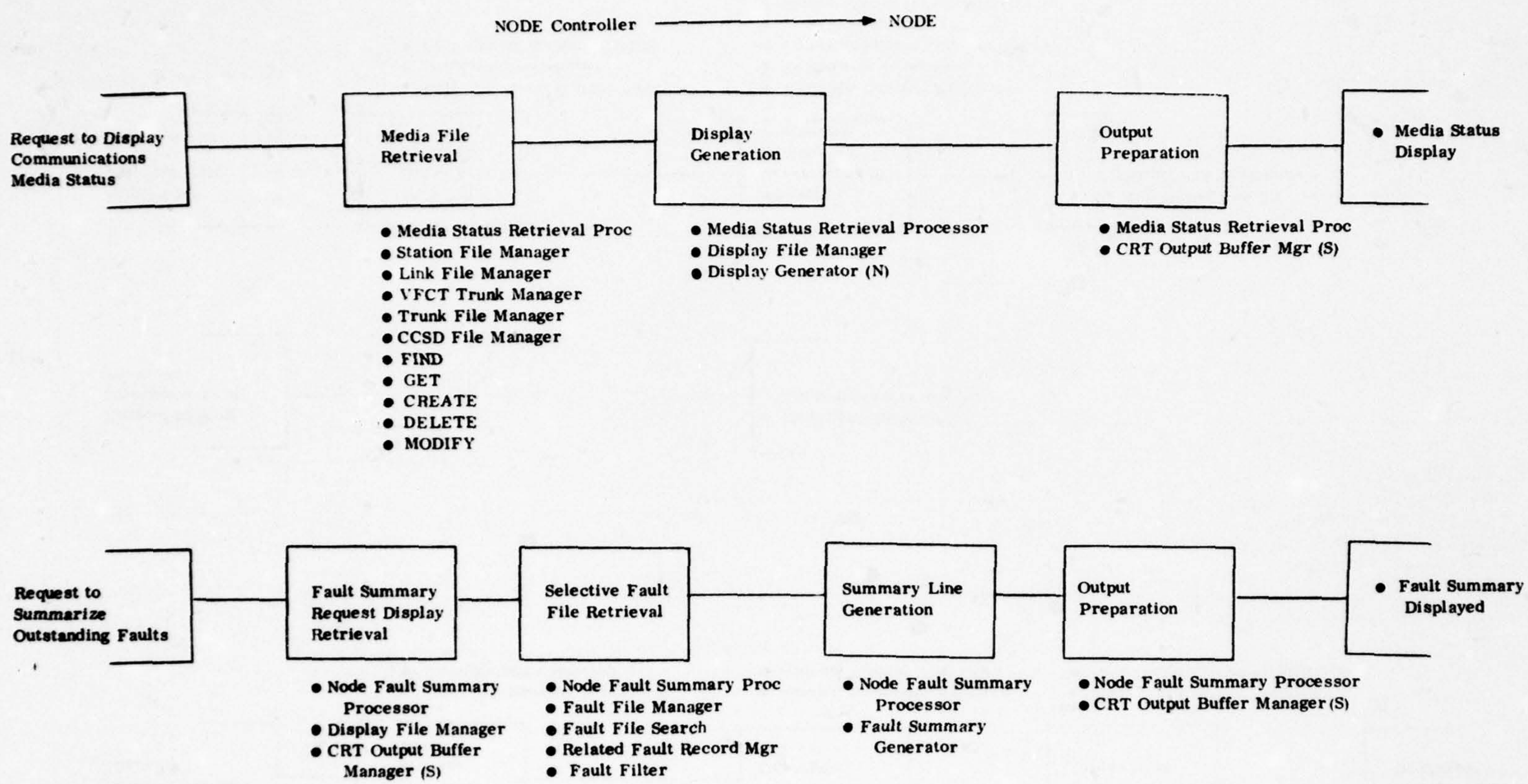


Figure 3.3-4. Node Controller → Node THREAD Diagrams (Sheet 3 of 4)

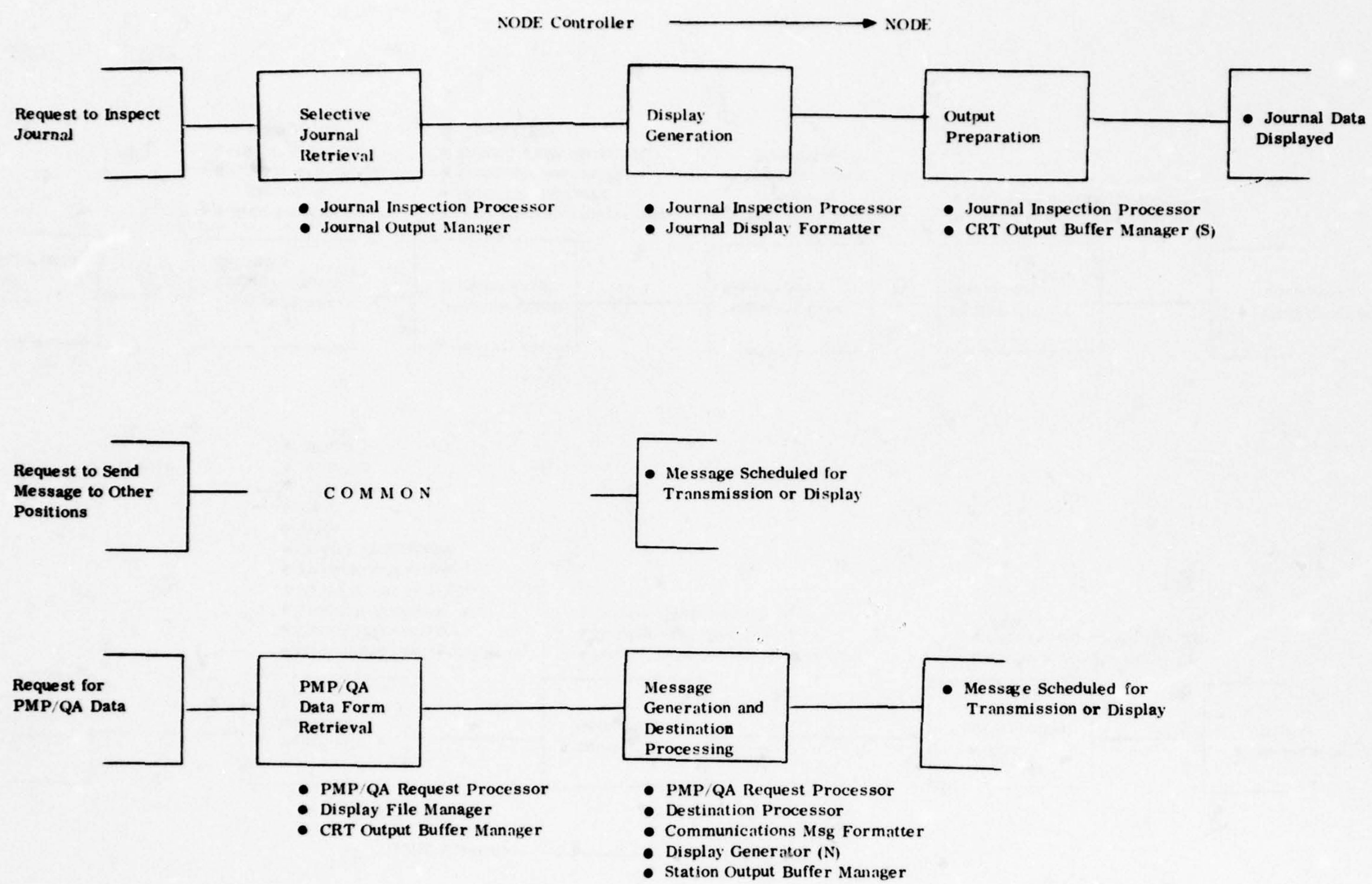


Figure 3.3-4. Node Controller → Node THREAD Diagrams (Sheet 4 of 4)

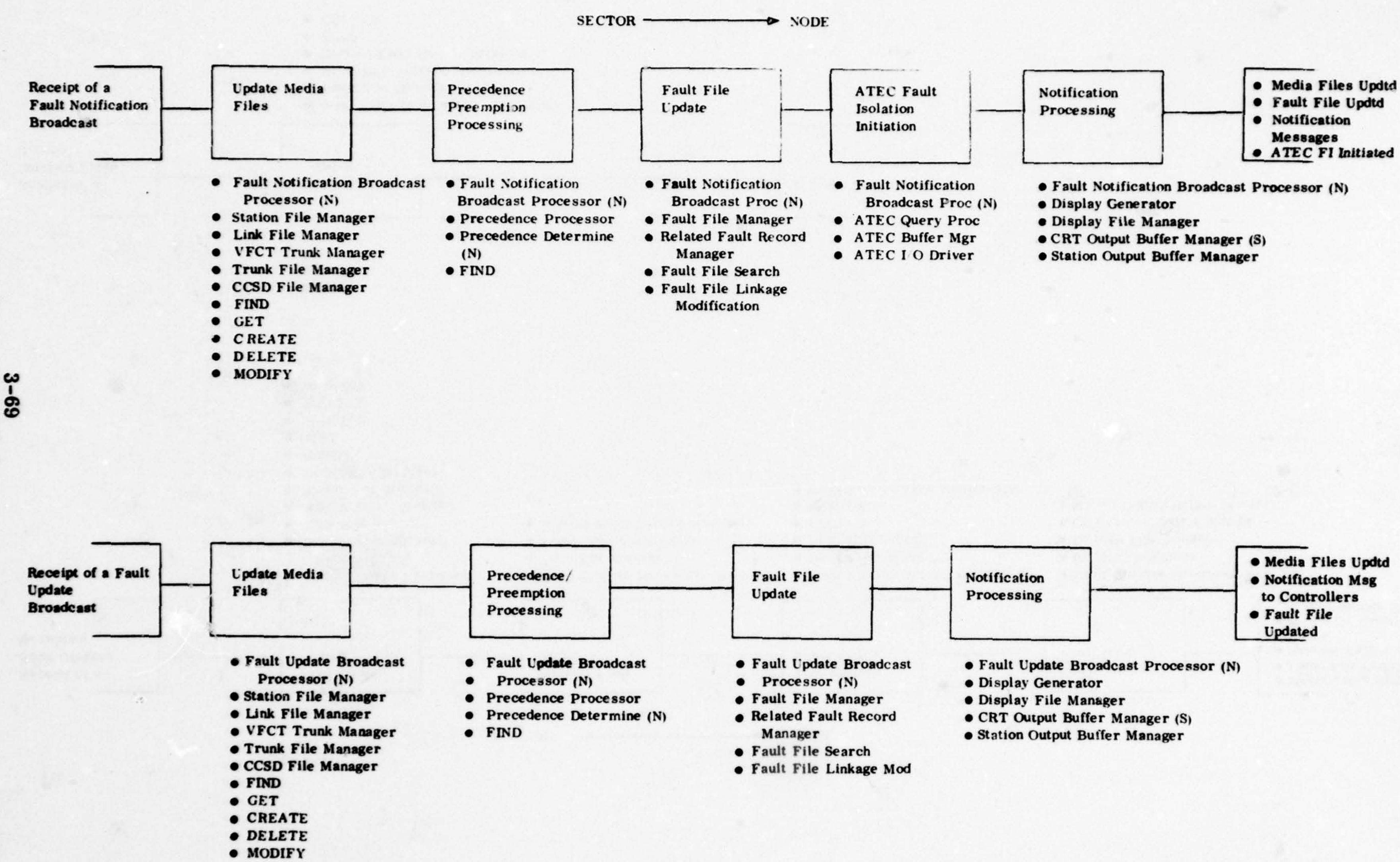


Figure 3.3-5. Sector → Node THREAD Diagrams (Sheet 1 of 6)

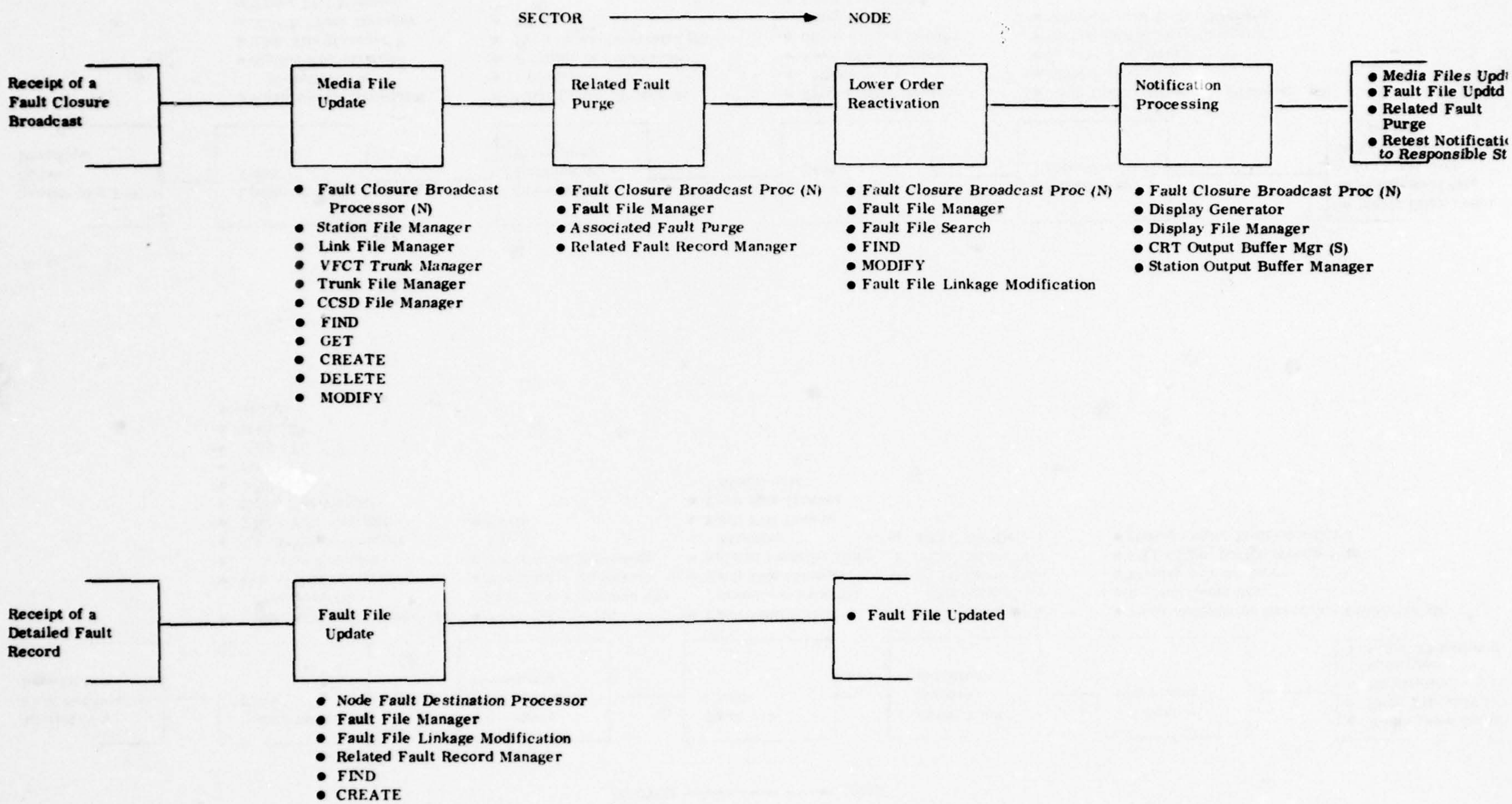


Figure 3.3-5. Sector → Node THREAD Diagrams
(Sheet 2 of 6)

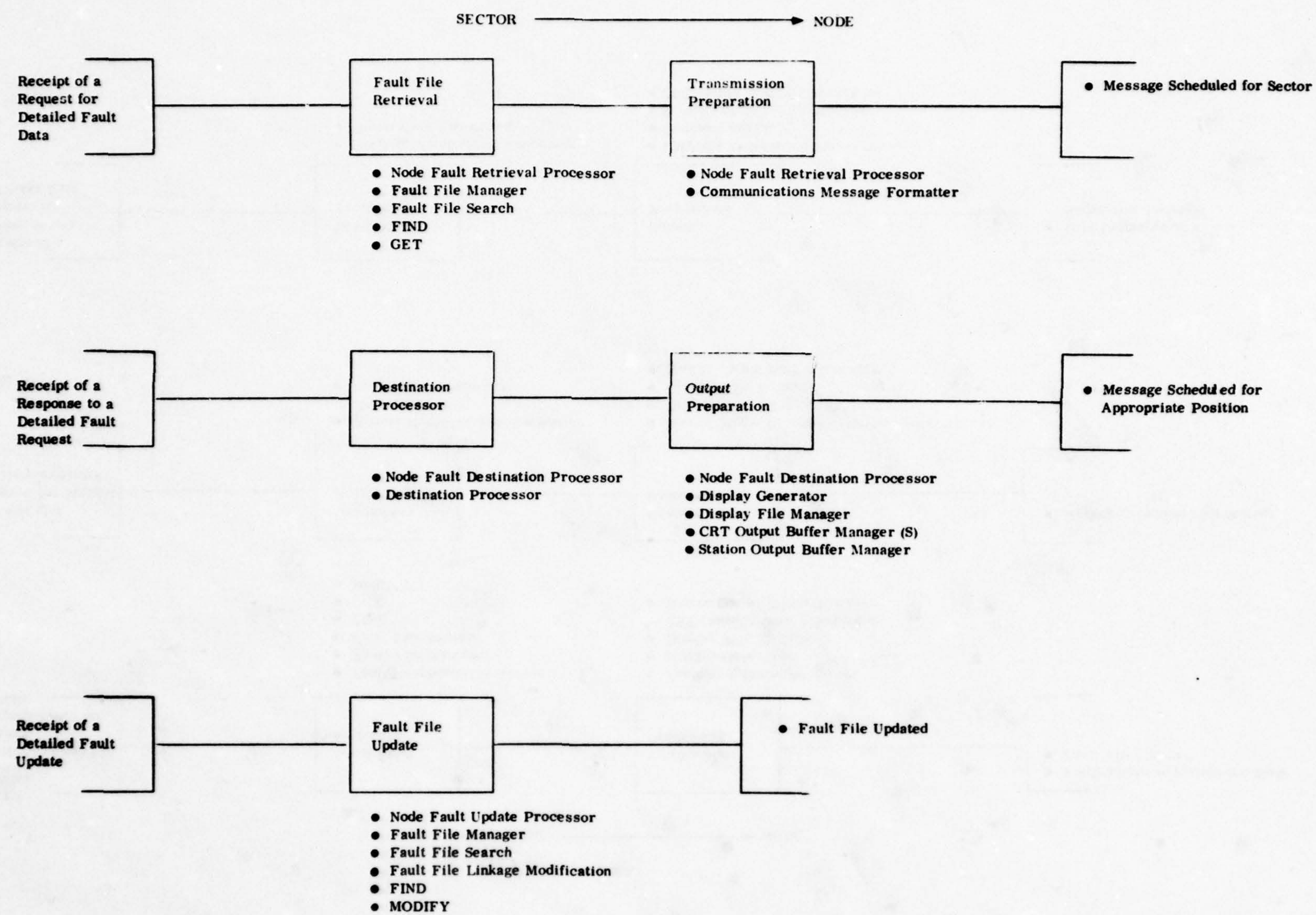


Figure 3.3-5. Sector → Node THREAD Diagrams (Sheet 3 of 6)

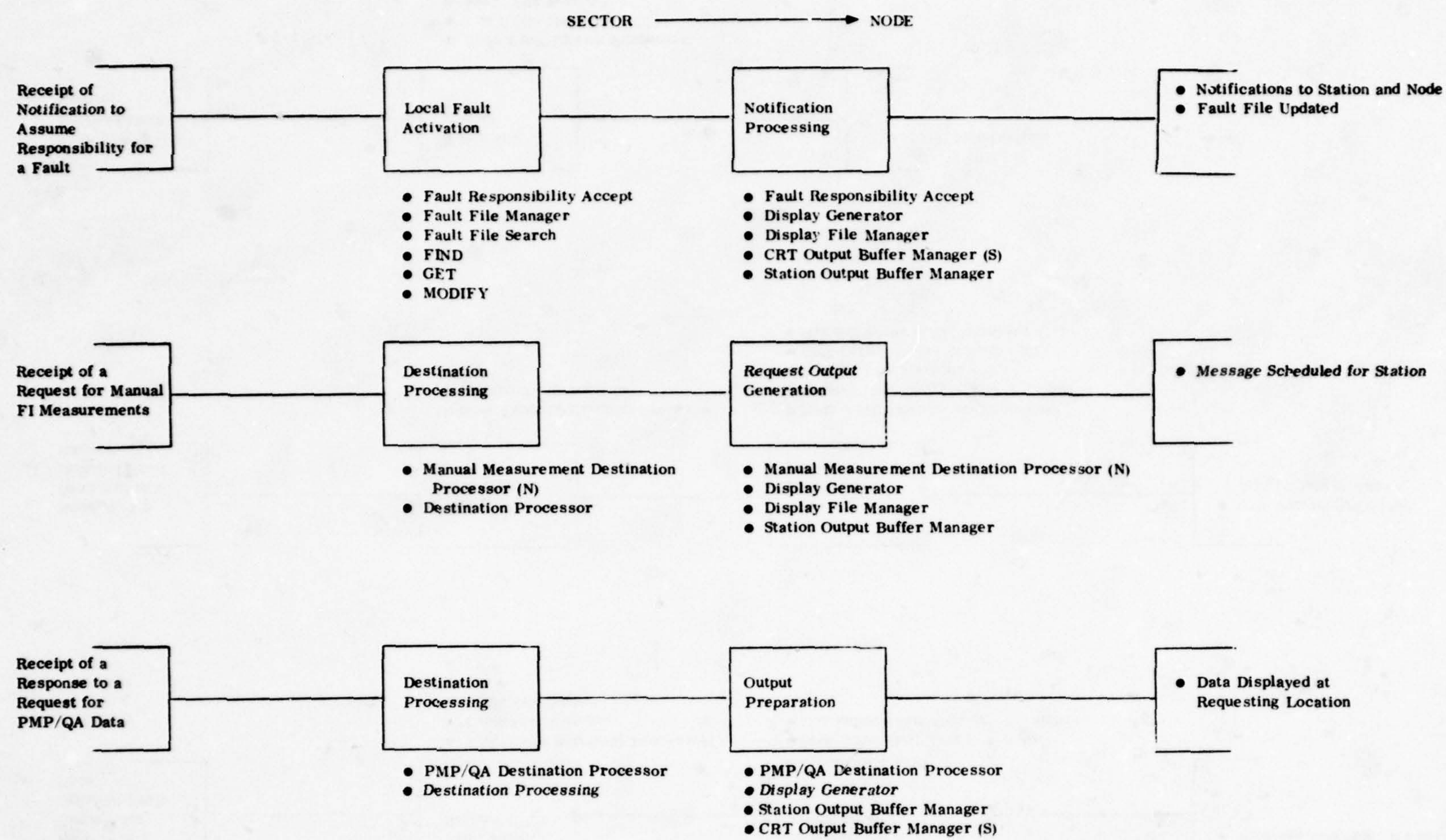


Figure 3.3-5. Sector → Node THREAD Diagrams
(Sheet 4 of 6)

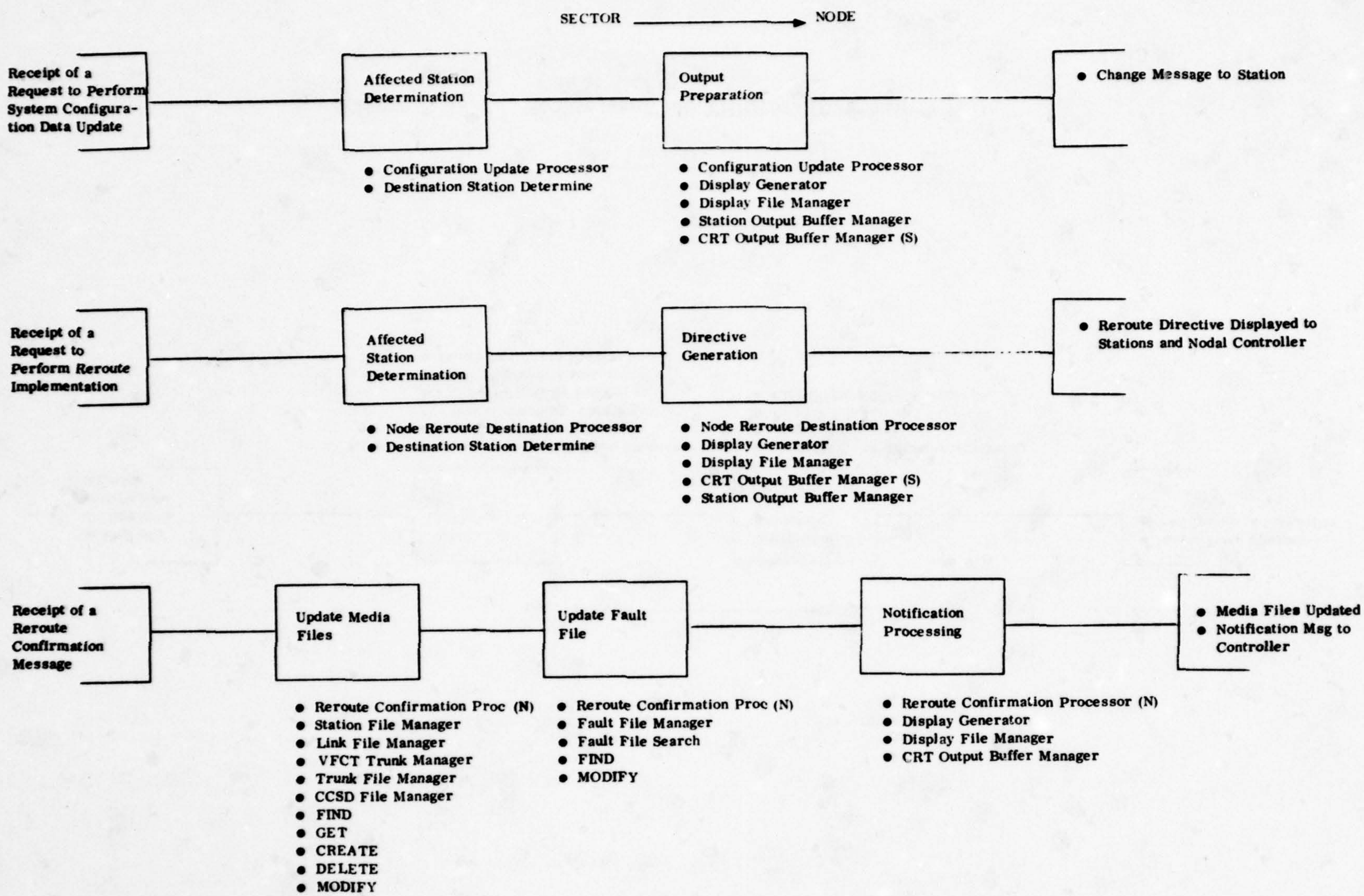


Figure 3.3-5. Sector → Node THREAD Diagrams
(Sheet 5 of 6)

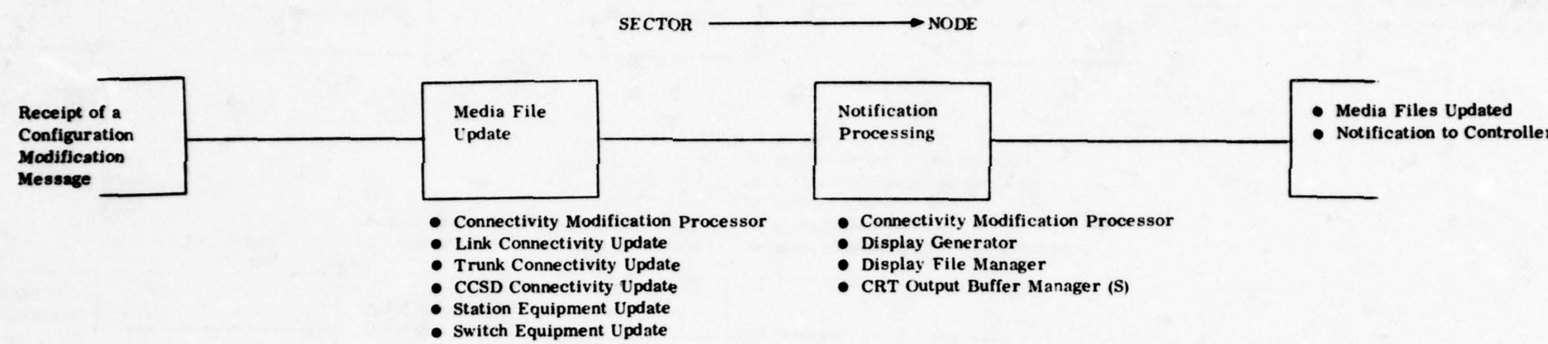


Figure 3.3-5. Sector → Node THREAD Diagrams (Sheet 6 of 6)

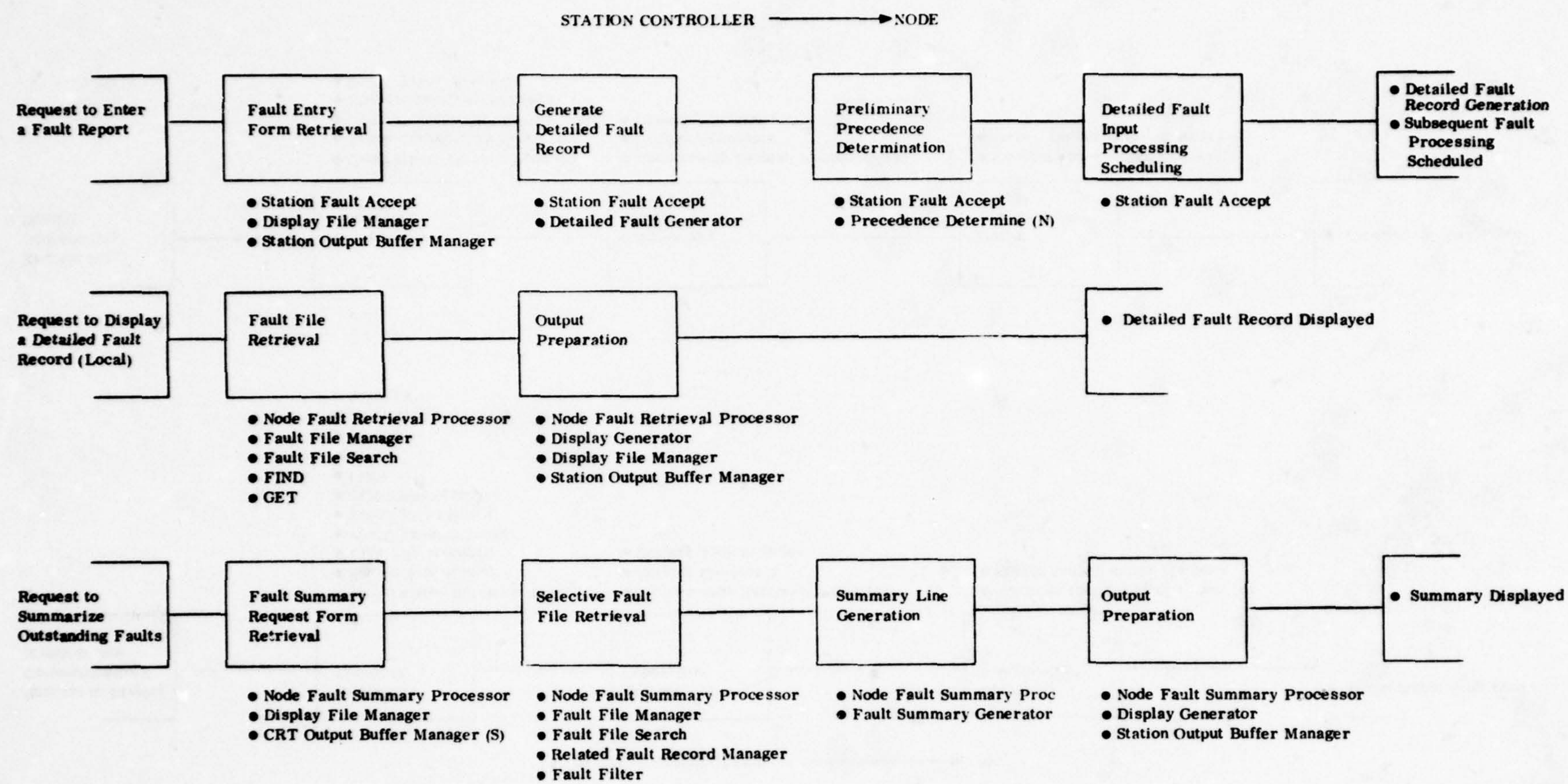


Figure 3.3-6. Station Controller→Node THREAD Diagrams (Sheet 1 of 6)

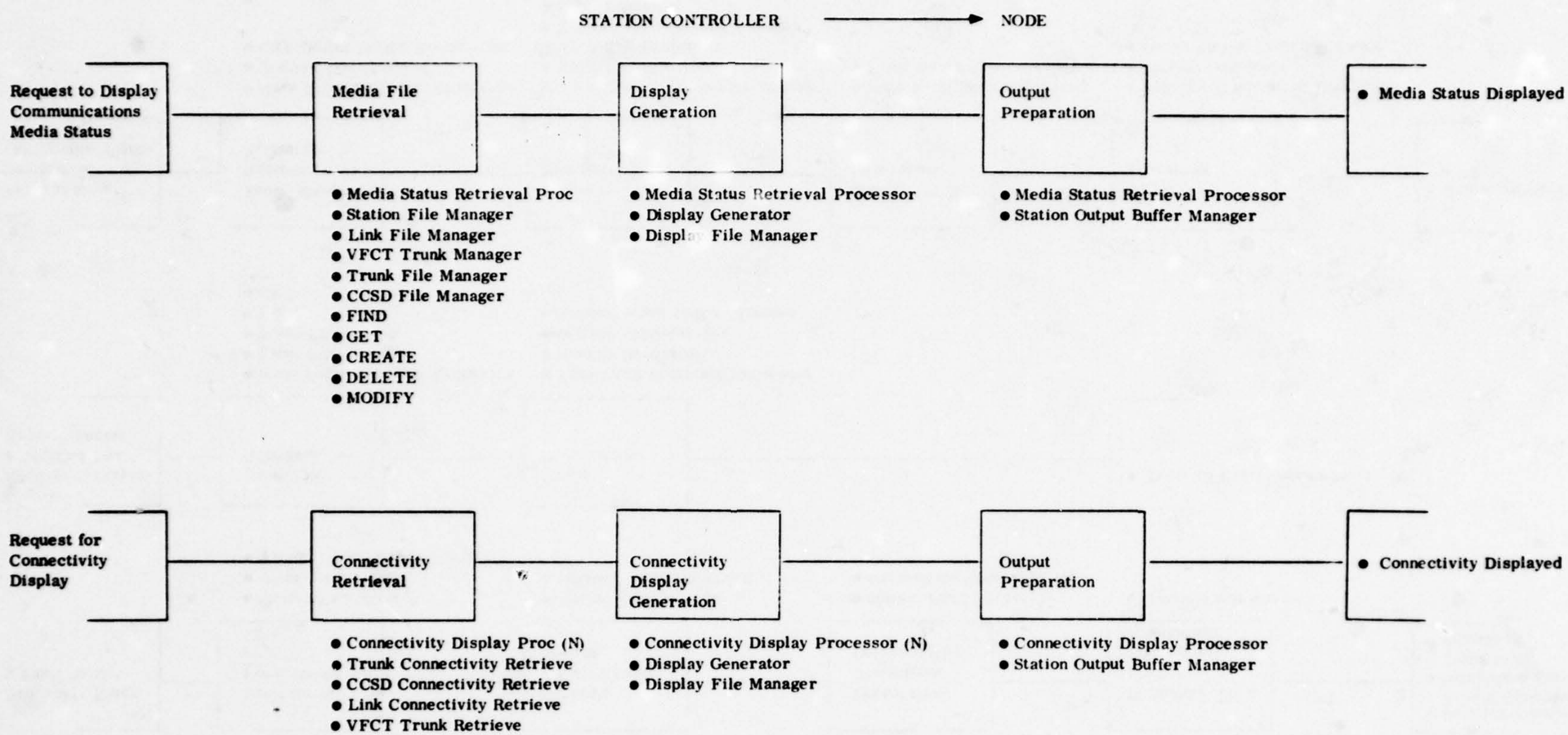


Figure 3.3-6. Station Controller→Node THREAD Diagrams (Sheet 2 of 6)

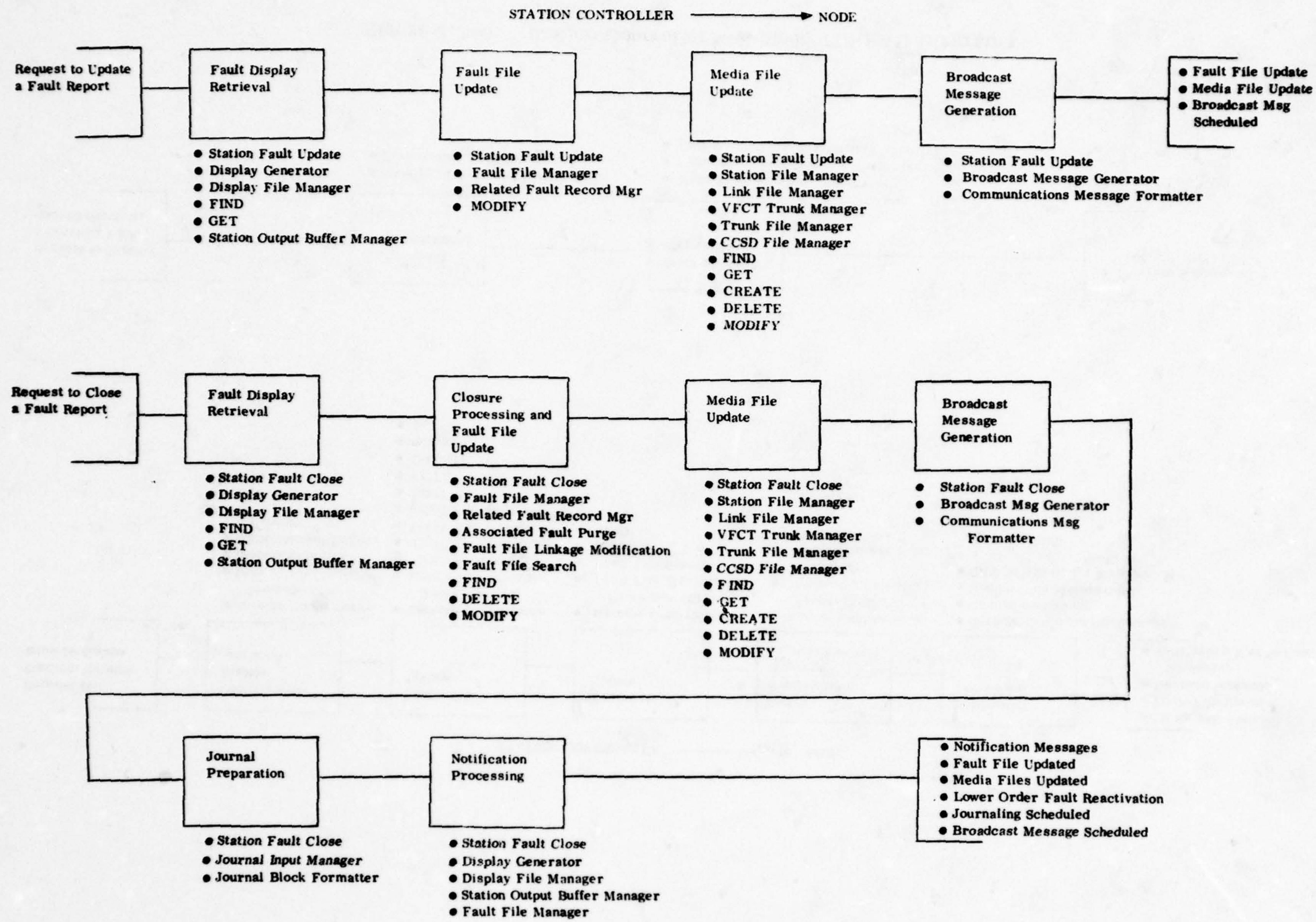


Figure 3.3-6. Station Controller → Node THREAD Diagrams (Sheet 3 of 6)

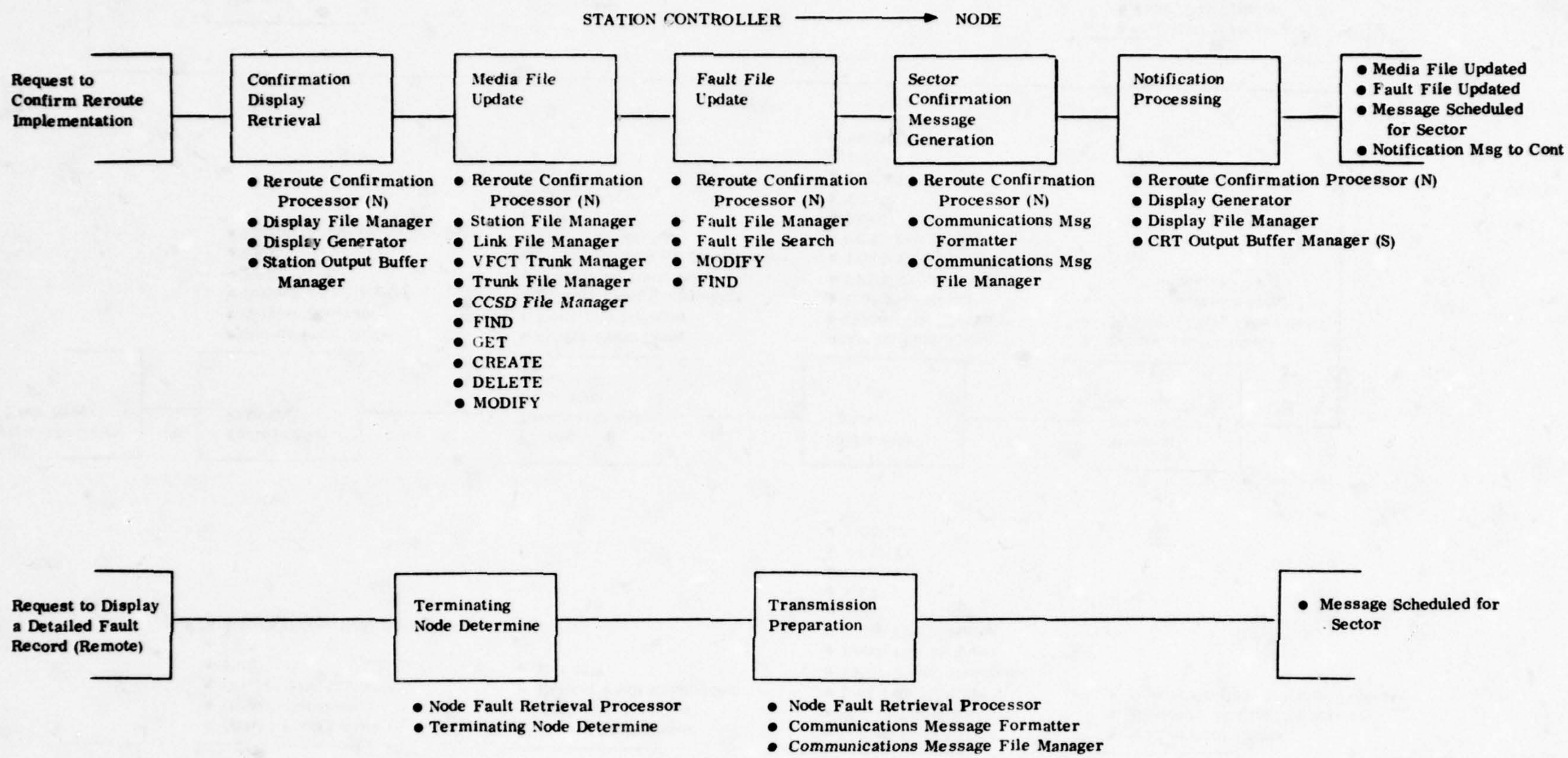


Figure 3.3-6. Station Controller → Node THREAD Diagrams (Sheet 4 of 6)

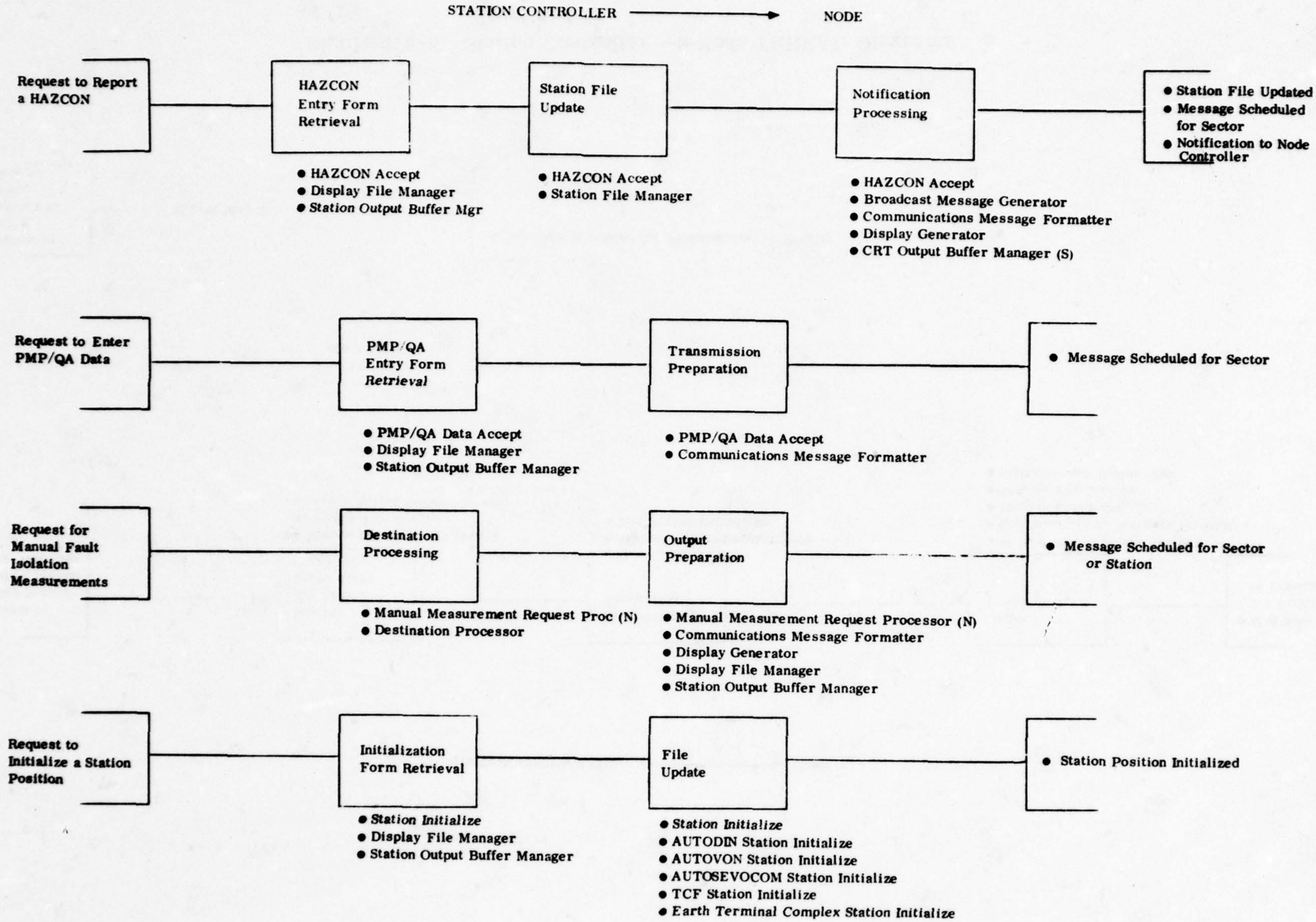


Figure 3.3-6. Station Controller → Node THREAD Diagrams (Sheet 5 of 6)

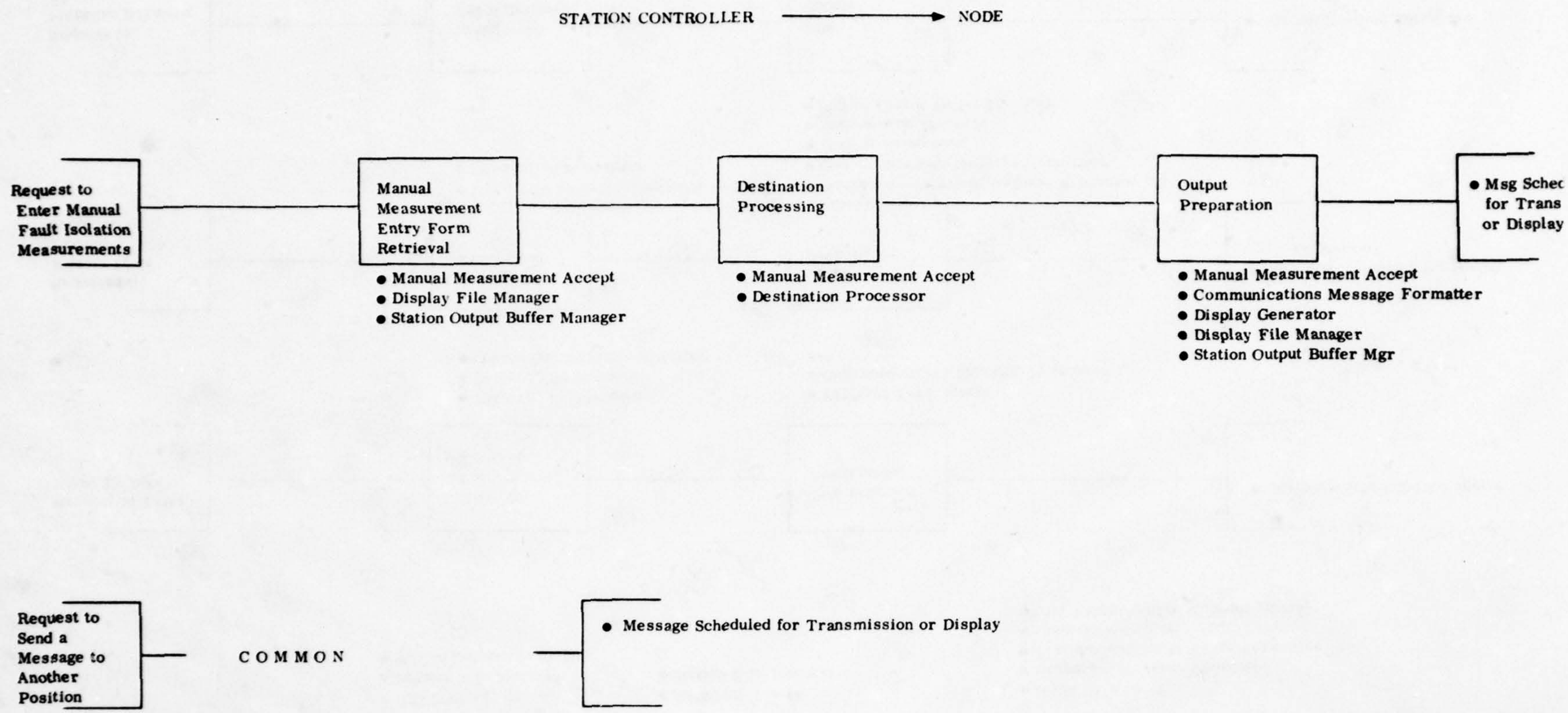


Figure 3.3-6. Station Controller → Node THREAD Diagrams (Sheet 6 of 6)

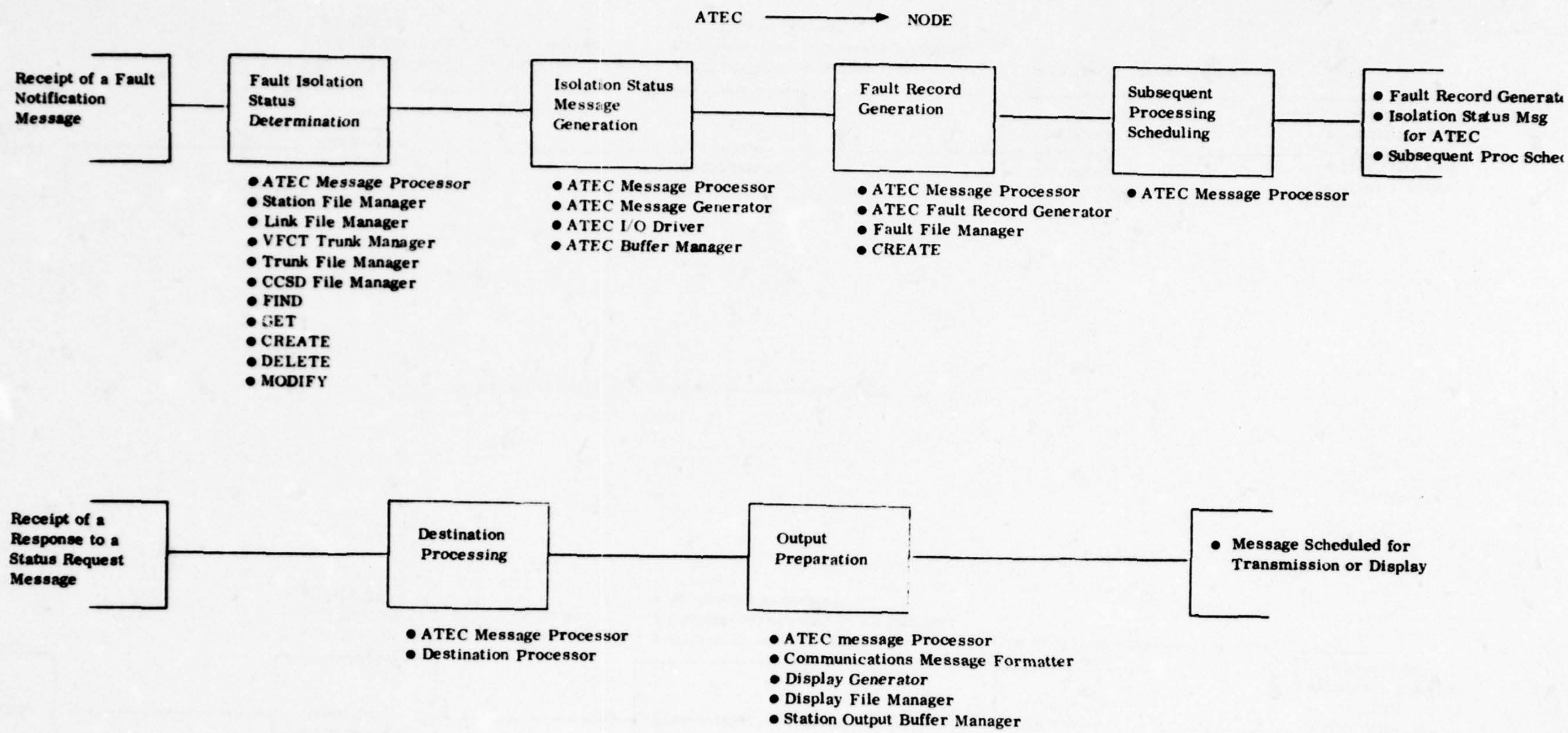


Figure 3. 3-7. ATEC ⟶ Node THREAD Diagrams

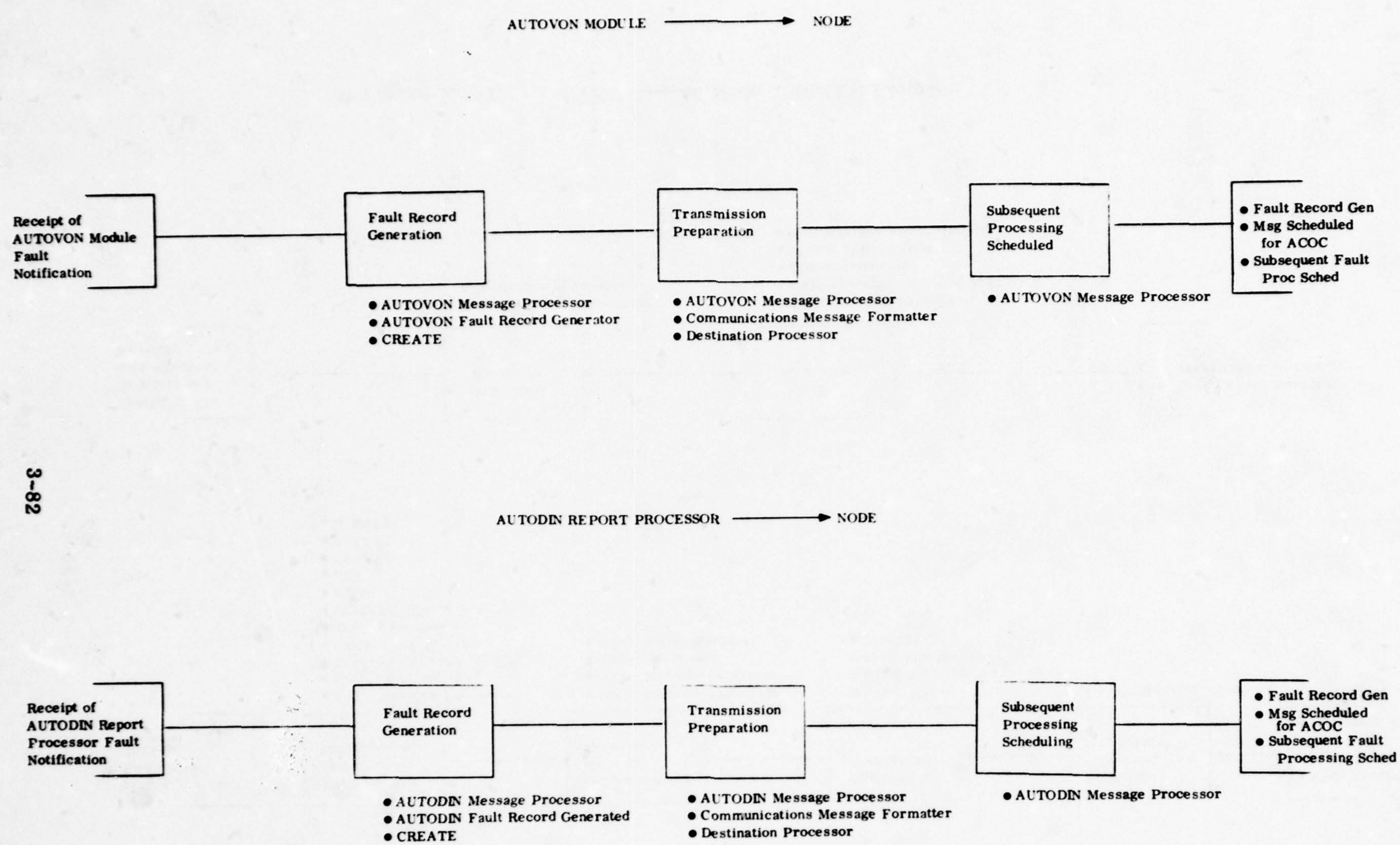


Figure 3.3-8. AUTOVON and AUTODIN→Node THREAD Diagrams

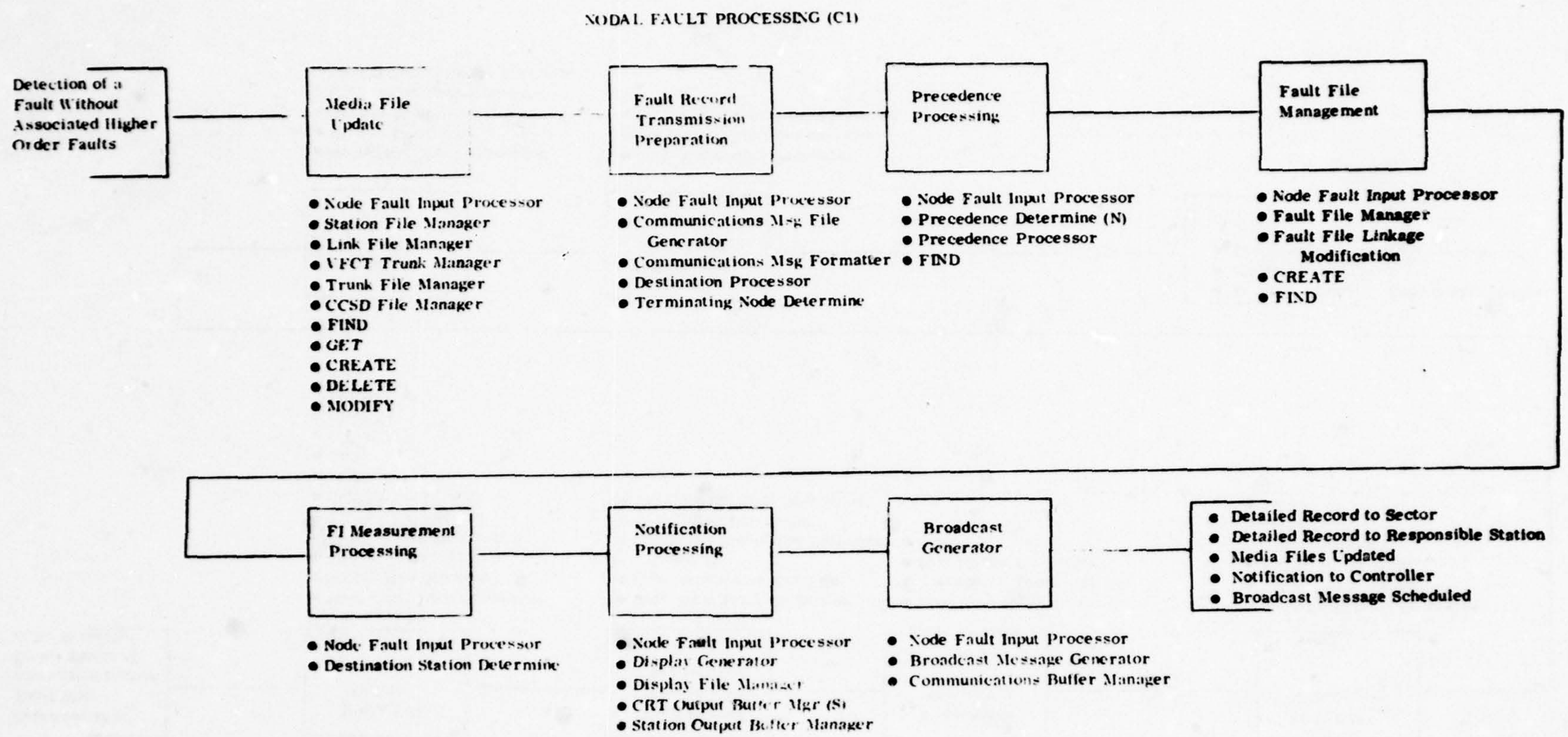


Figure 3.3-9. Nodal Fault Processing (C1) THREAD Diagram
(Sheet 1 of 2)

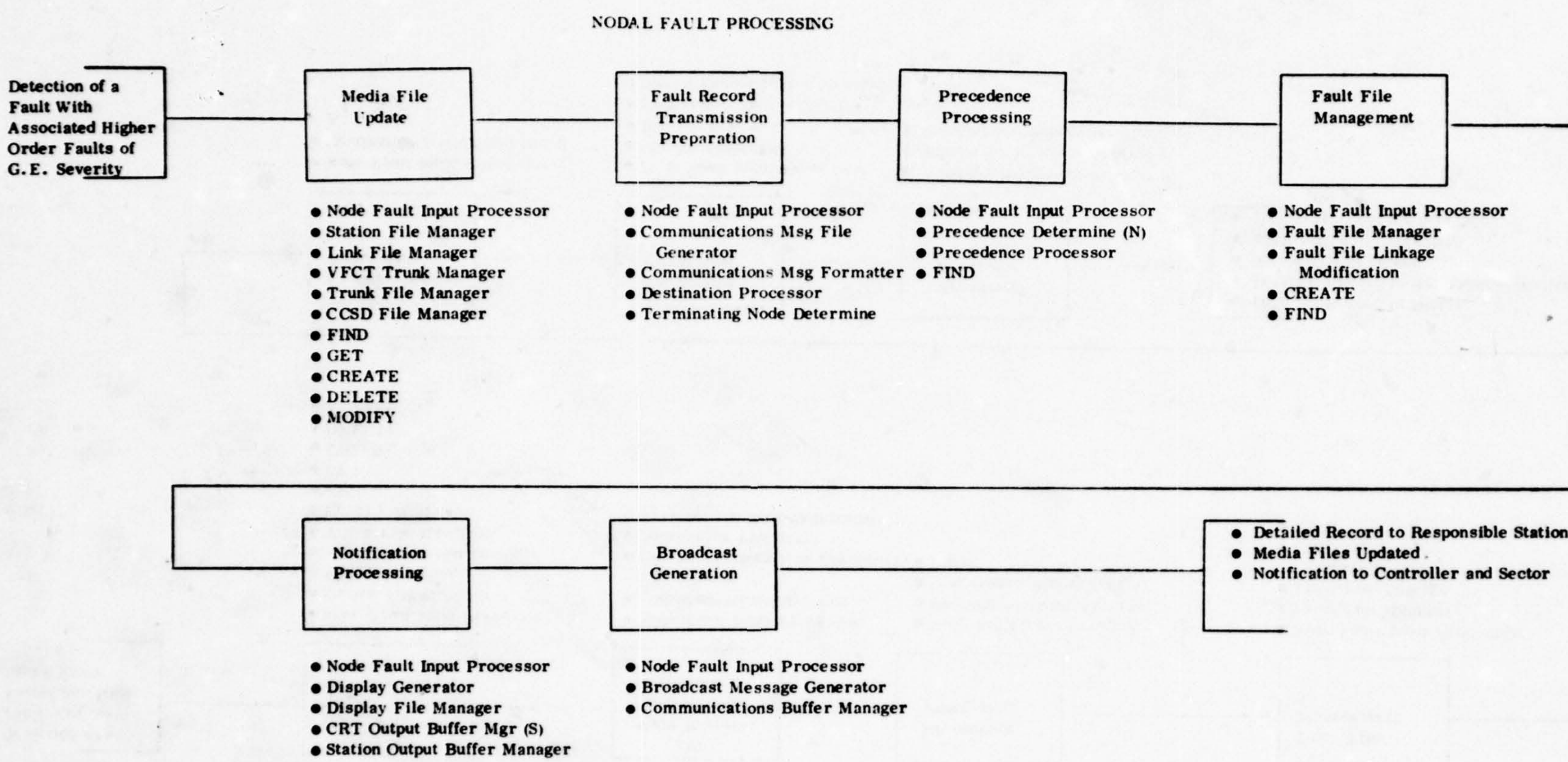
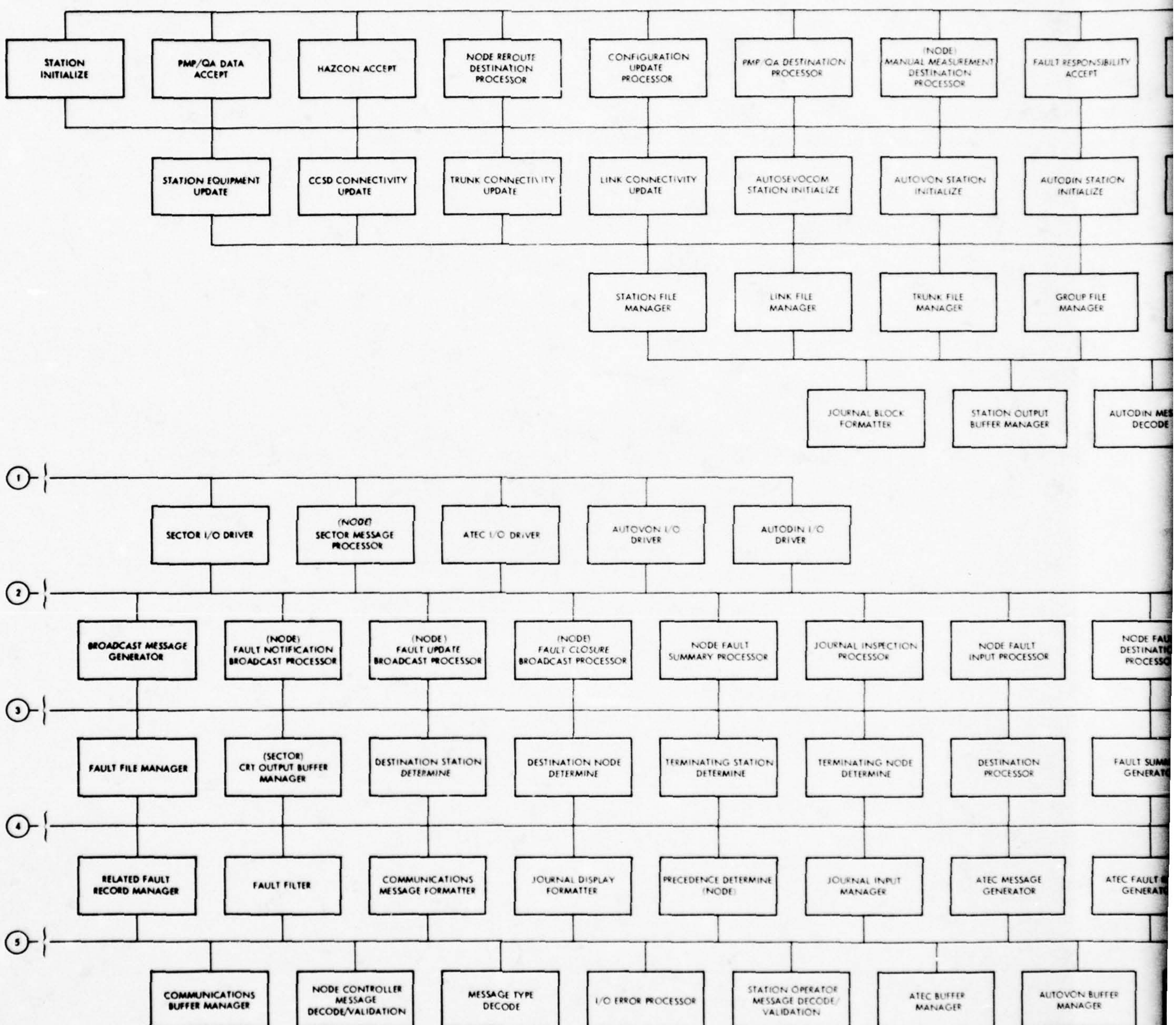


Figure 3.3-9. Nodal Fault Processing (C1) THREAD Diagram
(Sheet 2 of 2)


STATION INITIALIZE
PMP/QA DATA ACCEPT
HAZCON ACCEPT
NODE REROUTE DESTINATION PROCESSOR
CONFIGURATION UPDATE PROCESSOR
PMP/QA DESTINATION PROCESSOR
(NODE) MANUAL MEASUREMENT DESTINATION PROCESSOR
FAULT RESPONSIBILITY ACCEPT
STATION EQUIPMENT UPDATE
CCSD CONNECTIVITY UPDATE
TRUNK CONNECTIVITY UPDATE
LINK CONNECTIVITY UPDATE
AUTOSEVOCOM STATION INITIALIZE
AUTOVON STATION INITIALIZE
AUTODIN STATION INITIALIZE
STATION FILE MANAGER
LINK FILE MANAGER
TRUNK FILE MANAGER
GROUP FILE MANAGER
JOURNAL BLOCK FORMATTER
STATION OUTPUT BUFFER MANAGER
AUTODIN MES DECODE
1
SECTOR I/O DRIVER
(NODE) SECTOR MESSAGE PROCESSOR
ATEC I/O DRIVER
AUTOVON I/O DRIVER
AUTODIN I/O DRIVER
2
BROADCAST MESSAGE GENERATOR
(NODE) FAULT NOTIFICATION BROADCAST PROCESSOR
(NODE) FAULT UPDATE BROADCAST PROCESSOR
(NODE) FAULT CLOSURE BROADCAST PROCESSOR
NODE FAULT SUMMARY PROCESSOR
JOURNAL INSPECTION PROCESSOR
NODE FAULT INPUT PROCESSOR
NODE FAU DESTINATI PROCESSO
3
FAULT FILE MANAGER
(SECTOR) CRT OUTPUT BUFFER MANAGER
DESTINATION STATION DETERMINE
DESTINATION NODE DETERMINE
TERMINATING STATION DETERMINE
TERMINATING NODE DETERMINE
DESTINATION PROCESSOR
FAULT SUMM GENERATO
4
RELATED FAULT RECORD MANAGER
FAULT FILTER
COMMUNICATIONS MESSAGE FORMATTER
JOURNAL DISPLAY FORMATTER
PRECEDENCE DETERMINE (NODE)
JOURNAL INPUT MANAGER
ATEC MESSAGE GENERATOR
ATEC FAULT GENERAT
5
COMMUNICATIONS BUFFER MANAGER
NODE CONTROLLER MESSAGE DECODE/VALIDATION
MESSAGE TYPE DECODE
I/O ERROR PROCESSOR
STATION OPERATOR MESSAGE DECODE/VALIDATION
ATEC BUFFER MANAGER
AUTOVON BUFFER MANAGER

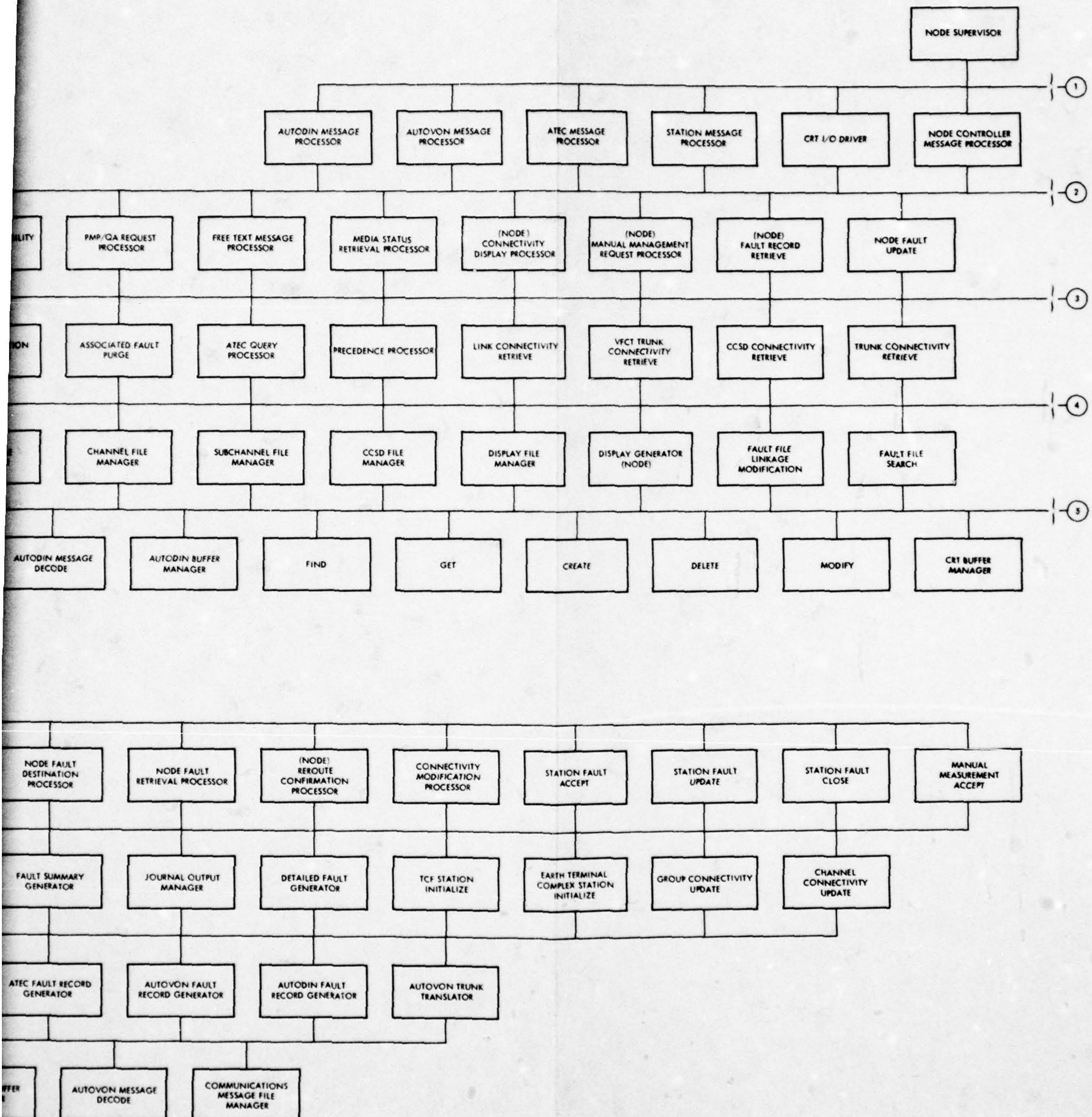


Figure 3.3-10. Computer Program Hierarchy for the Node

Node Processing Load:

$$P_N = P_{FAULT} + P_{SECTOR} + P_{DISK} + P_{I/O} \quad (1)$$

$$P_N = L_{FAULT}\, R_{FAULT} + L_{SECTOR}\, R_{SECTOR} + P_{DISK} + P_{I/O} \quad (2)$$

where

L_X = Number of instructions due to X

R_X = Rate of occurrence of X

$$L_{FAULT} = (I_{FAULT})\ (\text{TIME CONVERSION}) \quad (3)$$

$$= (I_{AVG(N2-N5)} + I_{N6})\ \left(\frac{MIN}{SEC}\right)$$

$$= (426 + 3330)\left(\frac{1}{60}\right)$$

$$= 62.60$$

$$L_{SECTOR} = (I_{N1})\ \left(\frac{MIN}{SEC}\right) \quad (4)$$

$$= (3490)\ \left(\frac{1}{60}\right)$$

$$= 58.17$$

$$P_{DISK} = 256\ D_N \quad (5)$$

where

D_N = Disk Load (see Figure 3.3-13)

$P_{I/O}$ = 6,900 (see Table 3.3-7) (6)

so

$$P_N = 62.60\ R_{FAULT} + 58.17\ R_{SECTOR} + 256\ D_N + 6{,}900 \quad (7)$$

Figure 3.3-11. Derivation of the Node Processing Load

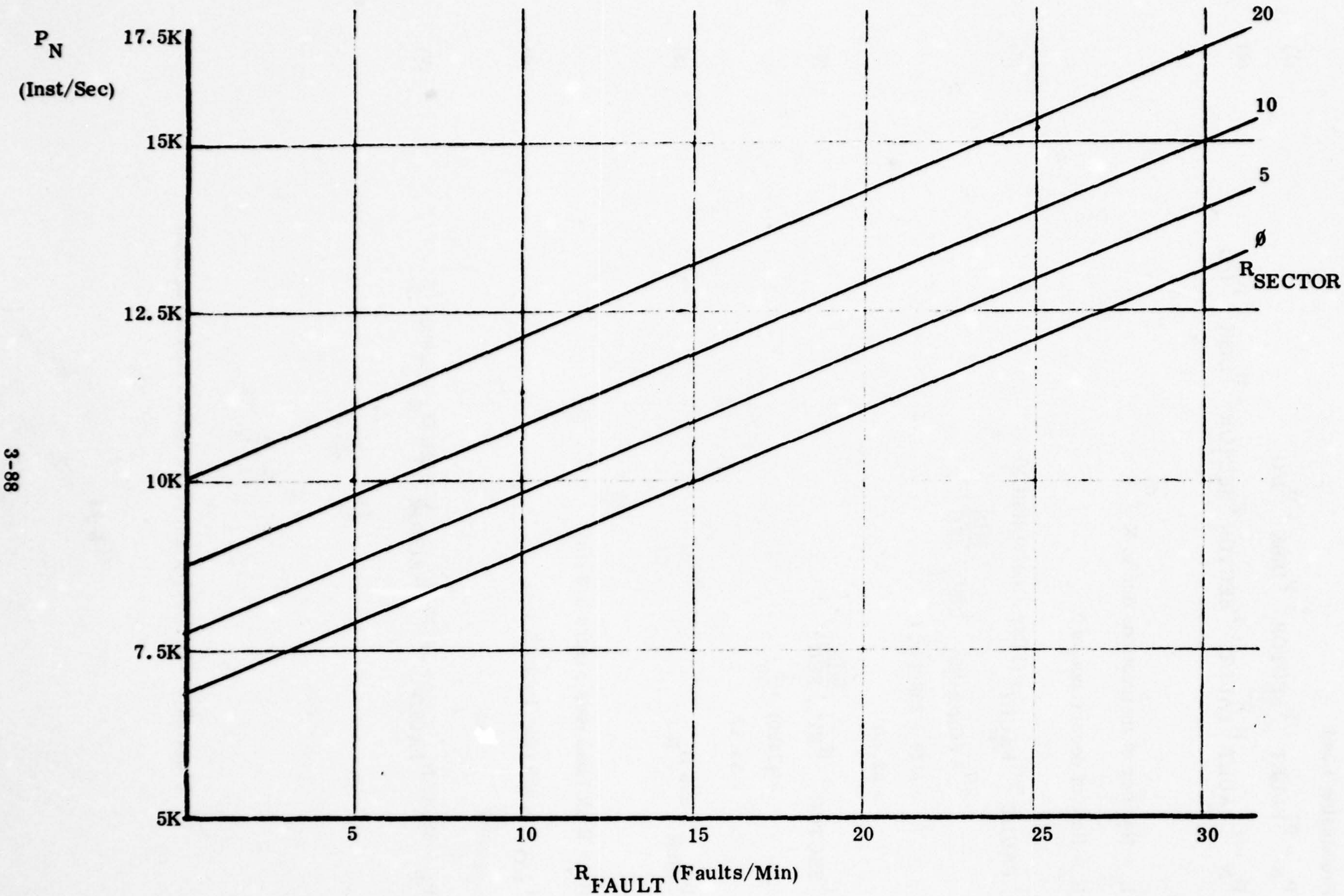


Figure 3.3-12. Node Processing Load

Node Disk Load:

$$D_N = D_{FAULT} + D_{SECTOR} \tag{1}$$

$$D_N = A_{FAULT}\, R_{FAULT} + A_{SECTOR}\, R_{SECTOR} \tag{2}$$

where

A_X = Number of accesses due to X

R_X = Rate of occurrence of X

$$A_{FAULT} = (A_{N2-N5} + A_{N6}) \left(\frac{MIN}{SEC}\right) \tag{3}$$

$$= (28) \left(\frac{1}{60}\right)$$

$$= 0.47$$

$$A_{SECTOR} = (A_{N1}) \left(\frac{MIN}{SEC}\right) \tag{4}$$

$$= (28) \left(\frac{1}{60}\right)$$

$$= 0.47$$

so:

$$D_N = 0.47 (R_{FAULT} + R_{SECTOR}) \tag{5}$$

Figure 3.3-13. Derivation of the Node Disk Load

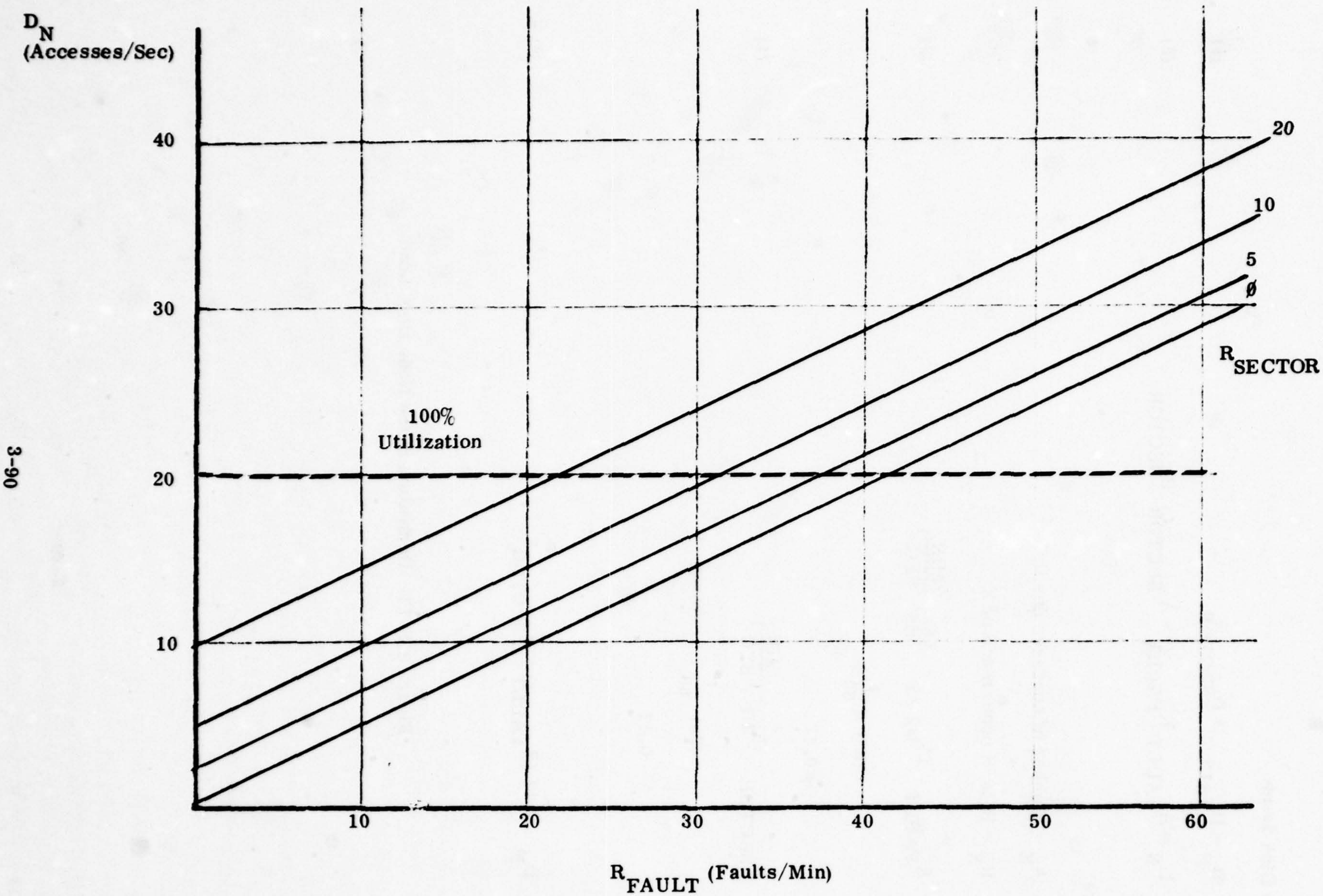


Figure 3.3-14. Node Disk Load

Table 3.3-1. Guide to Node Level Detailed THREAD Diagrams

Element	Figure Containing Detailed Flow Diagrams
Supervisory and I/O Level	3.3-3
Node Controller	3.3-4
Sector	3.3-5
Station Controller	3.3-6
ATEC	3.3-7
AUTOVON and AUTODIN	3.3-8
Fault Entry Processing	3.3-9

Table 3.3-2. Node Sizing Summary (Sheet 1 of 4)

PROGRAM NAME	FUNCTION	# INST HOL	PROG OCCUPANCY (Bytes)	DATA OCCUPANCY (Bytes)	COMMON	NODAL CONT	SECTOR	STATION CONT	ATEC	AUTODIN REPORT PROC	AUTOVON MOD			
Node Supervisor	Controls all scheduled software activities	300	4500		X									
CRT I/O Driver	Performs CRT line handling	200	3000	2000	X									
Sector I/O Driver	Performs Sector line handling	100	1500	1000	X									
ATEC I/O Driver	Performs ATEC line handling	100	1500	200	X									
AUTOVON I/O Driver	Performs AUTOVON line handling	100	1500	200	X									
AUTODIN I/O Driver	Performs AUTODIN line handling	100	1500	200	X									
Sector Message Processor (N)	Performs preliminary message processing of sector input	50	750				X							
Node Controller Message Processor	Performs preliminary message processing of nodal controller input	50	750			X								
Station Message Processor	Performs preliminary message processing of station input	50	750					X						
ATEC Message Processor	Performs preliminary message processing of ATEC input	50	750						X					
AUTOVON Message Processor	Performs preliminary message processing of AUTOVON input	50	750								X			
AUTODIN Message Processor	Performs preliminary message processing of AUTODIN input	50	750							X				
Journal Inspection Processor (N)	Controls retrieval of Journal data for operator inspection	275	4125			X								
Fault Notification Broadcast Processor (N)	Supervises processing of fault notifications at the node	275	4125		X									
Fault Update Broadcast Processor (N)	Supervises processing of fault updates at the node	275	4125		X									
Fault Closure Broadcast Processor (N)	Supervises processing of fault closures at the node	275	4125		X									
Broadcast Message Generator	Formats a broadcast message	200	3000		X									
Node Fault Summary Processor	Supervises summarization of outstanding faults	100	1500		X									
Fault Record Retrieve (N)	Supervises retrieval of detailed fault records for controller display	100	1500		X									
Node Fault Retrieval Processor	Supervises retrieval of detailed fault records for other U.C. levels	75	1125		X									
Node Fault Destination Processor	Supervises routing of detailed fault data to requesting position	75	1125				X							
Node Fault Input Processor	Supervises nodal processing of locally reported faults	400	6000		X									
Node Fault Update	Supervises fault updating by nodal controller.	150	2250			X								
Fault Responsibility Accept	Performs station notification to assume fault responsibility	75	1125				X							
Station Fault Accept	Supervises acceptance of station controller entered faults	100	1500					X						
Station Fault Update	Supervises updating of faults by the station controller	150	2250					X						
Station Fault Close	Supervises fault closures performed by the station controller	200	3000					X						
Connectivity Display Processor (N)	Supervises retrieval and display of connectivity data	200	3000		X									
Connectivity Modification Processor	Supervises modification of connectivity	500	7500		X									

Table 3.3-2. Node Sizing Summary (Sheet 2 of 4)

PROGRAM NAME	FUNCTION	# INST HOL	PROG OCCUPANCY (Bytes)	DATA OCCUPANCY (Bytes)	COMMON	NODAL CONT	SECTOR	STATION CONT	ATEC	AUTODIN REPORT PROC	AUTOVON MOD			
Configuration Update Processor	Determines appropriate stations to implement configuration change directives	50	750				X							
Node Reroute Destination Processor	Determines and notifies affected stations to perform reroute activities	50	750				X							
Reroute Confirmation Processor (N)	Supervises data base update upon confirmation receipt from controller	200	3000		X									
Media Status Retrieval Processor	Supervises retrieval of media status for a controller	250	3750		X									
PMP/QA Request Processor	Accepts and forwards requests for PMP/QA data	50	750		X									
PMP/QA Data Accept	Accepts PMP/QA data from controller and formats for transmission	75	1125					X						
PMP/QA Destination Processor	Accepts and forwards the PMP/QA data to the requesting position	50	750				X							
Manual Measurement Request Processor (N)	Accepts and forwards requests for manual FI measurements	50	750		X									
Manual Measurement Accept	Accepts station controller entered manual fault isolation measurements	75	1125					X						
Manual Measurement Destination Proc (N)	Routes manual FI measurements received from sector to requesting controller	50	750				X							
Free Text Message Processor	Supervises routing/display of free text messages	50	750		X									
HAZCON Accept	Accepts station controller entered HAZCONS and performs updates	100	1500					X						
Station Initialize	Supervises system initialization with data supplied by station positions	50	750					X						
Link Connectivity Retrieve	Performs link connectivity retrieval from media files	50	750		X									
VFCT Trunk Connectivity Retrieve	Performs VFCT trunk connectivity retrieval from media files	200	3000		X									
CCSD Connectivity Retrieve	Performs CCSD connectivity retrieval from media files	200	3000		X									
Trunk Connectivity Retrieve	Performs trunk connectivity retrieval from media files	100	1500		X									
Link Connectivity Update	Performs link connectivity updates in the media files	100	1500		X									
Trunk Connectivity Update	Performs trunk connectivity updates in the media files	200	3000		X									
CCSD Connectivity Update	Performs CCSD connectivity updates in the media files	400	6000		X									
Station Equipment Update	Performs station equipment file updates	100	1500		X									
VFCT Trunk Connectivity Update	Performs VFCT trunk connectivity updates in the media files	400	6000		X									
Precedence Processor	Determines precedence of reported fault relative to current system status	400	6000		X									
Destination Processing	Determines routing for unified control messages	50	750		X									
Destination Node Determine	Determines all nodes with jurisdiction over a given circuit, trunk or link	150	2250		X									
Destination Station Determine	Determines all stations with jurisdiction over a given circuit, trunk or link	150	2250				X							
Terminating Node Determine	Determines the node with jurisdiction over the terminating station for a given circuit, trunk, or link	50	750		X									
Terminating Station Determine	Determines the terminating station for a given circuit, trunk, or link	50	750		X									

Table 3.3-2. Node Sizing Summary (Sheet 3 of 4)

PROGRAM NAME	FUNCTION	# INST HOL	PROG OCCUPANCY (Bytes)	DATA OCCUPANCY (Bytes)	COMMON	NODAL CONT	SECTOR	STATION CONT	ATEC	AUTODIN REPORT PROC	AUTOVON MODULE			
Fault File Manager	Provides access to the fault file	150	2250		X									
Fault Summary Generator	Formats a fault summary line	50	750		X									
Associated Fault Purge	Performs purge processing of related faults upon closure	100	1500		X									
Detailed Fault Generator	Formats a detailed fault record	75	1125					X						
Journal Output Manager	Controls all output to the journal	50	750		X									
CRT Output Buffer Manager (S)	Controls all scheduled output to the node controller positions	100	1500		X									
ATEC Query Processor	Supervises the generation of ATEC query messages	150	2250		X									
AUTODIN Station Initialize	Accepts initialization data from an AUTODIN station position	50	750					X						
AUTOVON Station Initialize	Accepts initialization data from an AUTOVON station position	50	750					X						
AUTOSEVOCOM Station Initialize	Accepts initialization data from an AUTOSEVOCOM station position	50	750					X						
TCF Station Initialize	Accepts initialization data from a TCF station position	50	750					X						
Earth Terminal Complex Station Initialize	Accepts initialization data from an Earth terminal complex station position	50	750					X						
Station File Manager	Provides all access to the station file	175	2625		X									
Link File Manager	Provides all access to the link file	175	2625		X									
Trunk File Manager	Provides all access to the trunk file	150	2250		X									
VFCT Trunk Manager	Provides access to VFCT trunk data	175	2625		X									
CCSD File Manager	Provides all access to the CCSD File	200	3000		X									
Journal Input Manager	Processes all data into the journal	175	2625		X									
Journal Display Formatter	Formats data retrieved from the journal for display	100	1500			X								
Communications Message Formatter	Formats messages for data link transmission	150	2250		X									
Display File Manager	Performs retrieval of standard system displays	50	750		X									
Display Generator (N)	Parametrically builds system screen displays	50	750	300	X									
Fault File Search	Performs keyed searches of the fault file	75	1125		X									
Fault File Linkage Modification	Maintains fault file linkage integrity	150	2250		X									
Fault Filter	Applies selection filters on fault data for summary presentation	50	750		X									
Related Fault Record Manager	Maintains related fault record linkage	50	750		X									
Precedence Determine (N)	Determines precedence of a reported fault	100	1500		X									
ATEC Message Generator	Formats query messages for transmission to ATEC	50	750		X									
ATEC Fault Record Generator	Generates a detailed fault record from ATEC status data	75	1125						X					

Table 3.3-2. Node Sizing Summary (Sheet 4 of 4)

PROGRAM NAME	FUNCTION	# INST HOL	PROG OCCUPANCY (Bytes)	DATA OCCUPANCY (Bytes)	COMMON	NODAL CONT	SECTOR	STATION CONT	ATEC	AUTODIN REPORT PROC	AUTOVON MODULE
VON Fault Record Generator	Generates a detailed fault record from VON module status data	75	1125								X
DIN Fault Record Generator	Generates a detailed fault record from DIN R.P. status data	75	1125							X	
AUTOVON Trunk Translator	Translates AUTOVON Trunk ID to CCSD ID and vice versa	50	750		X						
Message Type Decode	Performs communications message type determination	175	2625				X				
Node Controller Decode/Validation	Performs node controller message type determination and validation	75	1125			X					
Station Operator Decode/Validation	Performs station controller message type determination and validation	100	1500					X			
AUTOVON Message Decode	Performs AUTOVON Message type determination	50	750								X
AUTODIN Message Decode	Performs AUTODIN Message type determination	50	750							X	
I/O Error Processor	Performs recovery processing upon communication error detection	150	2250				X				
Journal Block Formatter	Builds blocks of data for output to the journal	150	2250		X						
Communications Buffer Manager	Maintains the data link I/O buffers	100	1500		X						
CRT Buffer Manager	Maintains the CRT input buffers	75	1125		X						
Station Output Buffer Manager	Controls all scheduled output to the controller positions	200	3000		X						
AUTODIN Buffer Manager	Maintains the AUTODIN R.P. I/O buffers	100	1500							X	
ATEC Buffer Manager	Maintains the ATEC I/O buffers	100	1500						X		
AUTOVON Buffer Manager	Maintains the AUTOVON Module I/O buffers	100	1500								X
Communications Message File Manager	Performs retrieval of standard system communications messages	50	750		X						
FIND	Performs generic data base maintenance processing	500	7500		X						
GET	Performs generic data base maintenance processing	500	7500		X						
CREATE	Performs generic data base maintenance processing	500	7500		X						
DELETE	Performs generic data base maintenance processing	500	7500		X						
MODIFY	Performs generic data base maintenance processing	500	7500		X						
	Total Lines of Code - 15,475 lines										
	Total Program Occupancy - 232,125 Bytes										
	Total Data Occupancy - 3,900 Bytes										

Table 3.3-3. Node Resident and Support Overlay Sizing Summary

PROGRAM NAME	FUNCTION	# INST HOL	PROG OCCUPANCY (Bytes)	DATA OCCUPANCY (Bytes)	RESIDENT	NODAL CONT SUPPORT	SECTOR SUPPORT	STATION CCNT SUPPORT	ATEC	AUTODIN REPORT PROC	AUTOVON MOD
Node Supervisor	Controls all scheduled software activities	300	4500		X						
CRT I/O Driver	Performs CRT line handling	200	3000	2000	X						
Sector I/O Driver	Performs Sector line handling	100	1500	1000	X						
ATEC I/O Driver	Performs ATEC line handling	100	1500	220	X						
AUTOVON I/O Driver	Performs AUTOVON line handling	100	1500	200	X						
AUTODIN I/O Driver	Performs AUTODIN line handling	100	1500	200	X						
Sector Message Processor (N)	Performs preliminary message processing of sector input	50	750				X				
Node Controller Message Processor	Performs preliminary message processing of nodal controller input	50	750			X					
Station Message Processor	Performs preliminary message processing of station input	50	750					X			
ATEC Message Processor	Performs preliminary message processing of ATEC input	50	750						X		
AUTOVON Message Processor	Performs preliminary message processing of AUTOVON input	50	750								X
AUTODIN Message Processor	Performs preliminary message processing of AUTODIN input	50	750							X	
Destination Processing	Determines routing for unified control messages	50	750		X						
Destination Node Determine	Determines all nodes with jurisdiction over a given circuit, trunk or link	150	2250			X	X				
Destination Station Determine	Determines all stations with jurisdiction over a given circuit, trunk or link	150	2250			X	X				
Terminating Node Determine	Determines the node with jurisdiction over the terminating station for a given circuit, trunk, or link	50	750			X		X	X	X	X
Terminating Station Determine	Determines the terminating station for a given circuit, trunk, or link	50	750			X	X	X			
Fault File Manager	Provides access to the fault file	150	2250						X		
CRT Output Buffer Manager (S)	Controls all scheduled output to the node controller positions	100	1500			X	X		X	X	X
ATEC Query Processor	Supervises the generation of ATEC query messages	150	2250				X				
Station File Manager	Provides all access to the station file	175	2625			X	X	X	X	X	X
Link File Manager	Provides all access to the link file	175	2625			X	X	X	X	X	X
Trunk File Manager	Provides all access to the trunk file	150	2250			X	X	X	X	X	X
VFCT Trunk Manager	Provides access to VFCT trunk data	175	2625			X	X	X	X	X	X
CCSD File Manager	Provides all access to the CCSD file	200	3000			X	X	X	X	X	X
Journal Input Manager	Processes all data into the journal	175	2625					X			
Communications Message Formatter	Formats messages for data link transmission	150	2250			X		X	X	X	X
Display File Manager	Performs retrieval of standard system displays	50	750			X	X	X	X	X	X

Table 3.3-3. Node Resident and Support Overlay Sizing Summary

PROGRAM NAME	FUNCTION	# INST HOL	PROG OCCUPANCY (Bytes)	DATA OCCUPANCY (Bytes)	RESIDENT	NODAL CONT SUPPORT	SECTOR SUPPORT	STATION CONT SUPPORT	ATEC	AUTODIN REPORT PROC	AUTOVON MOD
Display Generator (N)	Parametrically builds system screen displays	50	750	300		X	X	X	X	X	X
ATEC Message Generator	Formats query messages for transmission to ATEC	50	750						X		
ATEC Fault Record Generator	Generates a detailed fault record from ATEC status data	75	1125						X		
VON Fault Record Generator	Generates a detailed fault record from VON module status data	75	1125								X
DIN Fault Record Generator	Generates a detailed fault record from DIN R. P. status data	75	1125							X	
AUTOVON Trunk Translator	Translates AUTOVON Trunk ID to CCSD ID and vice versa	50	750								X
Message Type Decode	Performs communications message type determination	175	2625				X				
Node Controller Decode/Validation	Performs node controller message type determination and validation	75	1125			X					
Station Operator Decode/Validation	Performs station controller message type determination and validation	100	1500					X			
AUTOVON Message Decode	Performs AUTOVON Message type determination	50	750								X
AUTODIN Message Decode	Performs AUTODIN Message type determination	50	750							X	
I/O Error Processor	Performs recovery processing upon communication error detection	150	2250				X		X	X	X
Journal Block Formatter	Builds blocks of data for output to the journal	150	2250					X			
Communications Buffer Manager	Maintains the data link I/O buffers	100	1500			X	X		X	X	X
CRT Buffer Manager	Maintains the CRT Input buffers	75	1125			X		X			
Station Output Buffer Manager	Controls all scheduled output to the controller positions	200	3000			X	X	X	X	X	X
AUTODIN Buffer Manager	Maintains the AUTODIN R. P I/O buffers	100	1500							X	
ATEC Buffer Manager	Maintains the ATEC I/O buffers	100	1500						X		
AUTOVON Buffer Manager	Maintains the AUTOVON Module I/O buffers	100	1500								X
Communications Message File Manager	Performs retrieval of standard system communications messages	50	750			X		X	X	X	X
FIND	Performs generic data base maintenance processing	500	7500		X						
GET	Performs generic data base maintenance processing	500	7500		X						
CREATE	Performs generic data base maintenance processing	500	7500		X						
DELETE	Performs generic data base maintenance processing	500	7500		X						
MODIFY	Performs generic data base maintenance processing	500	7500		X						
TOTAL OCCUPANCY					55350	32925	34050	30675	33300	31050	31800

Table 3.3-4 (Sheet 1). Node Functional Overlay Structure Sizing Summary

PROGRAM NAME	NO. INST HOL	Program Occupancy (bytes)	NODAL CONTROLLER Journal Inspection	Node Fault Summarization	Fault Record Retrieval	Node Fault Update	Connectivity Display	Media Status Retrieval	PMP/QA Data Request	Manual Measurement Req	Free Text Msg Processing									
Journal Inspection Processor (N)	275	4125	X																	
Fault Notification Broadcast Processor (N)	275	4125																		
Fault Update Broadcast Processor (N)	275	4125																		
Fault Closure Broadcast Processor (N)	275	4125																		
Broadcast Message Generator	200	3000				X														
Node Fault Summary Processor	100	1500		X																
Fault Record Retrieve (N)	100	1500			X															
Node Fault Retrieval Processor	75	1125																		
Node Fault Destination Processor	75	1125																		
Node Fault Input Processor	400	6000																		
Node Fault Update	150	2250				X														
Fault Responsibility Accept	75	1125																		
Station Fault Accept	100	1500																		
Station Fault Update	150	2250																		
Station Fault Close	200	3000																		
Connectivity Display Processor (N)	200	3000					X													
Connectivity Modification Processor	500	7500																		
Configuration Update Processor	50	750																		
Node Reroute Destination Processor	50	750																		
Reroute Confirmation Processor (N)	200	3000																		
Media Status Retrieval Processor	250	3750						X												
PMP/QA Request Processor	50	750							X											
PMP/QA Data Accept	75	1125																		
PMP/QA Destination Processor (N)	50	750																		
Manual Measurement Request Processor	50	750								X										
Manual Measurement Accept	75	1125																		
Manual Measurement Destination Proc (N)	50	750																		
Free Text Message Processor	50	750									X									
HAZCON Accept	100	1500																		

Table 3.3-4 (Sheet 2). Node Functional Overlay Structure Sizing Summary

PROGRAM NAME	NO. INST HOL	Program Occupancy (bytes)	NODAL CONTROLLER Journal Inspection	Node Fault Summarization	Fault Record Retrieval	Node Fault Update	Connectivity Display	Media Status Retrieval	PMP QA Data Request	Manual Measurement Req	Free Text Msg Processing
Station Initialize	50	750									
Link Connectivity Retrieve	50	750					X				
VFCT Trunk Connectivity Retrieve	200	3000					X				
CCSD Connectivity Retrieve	200	3000					X				
Trunk Connectivity Retrieve	100	1500					X				
Link Connectivity Update	200	3000									
Trunk Connectivity Update	200	3000									
CCSD Connectivity Update	400	6000									
Station Equipment Update	100	1500									
VFCT Trunk Connectivity Update	400	6000									
Precedence Processor	400	6000									
Fault File Manager	150	2250		X	X	X					
Fault Summary Generator	50	750		X							
Associated Fault Purge	100	1500									
Detailed Fault Generator	75	1125									
Journal Output Manager	50	750	X								
AUTODIN Station Initialize	50	750									
AUTOVON Station Initialize	50	750									
AUTOSEVOCOM Station Initialize	50	750									
TCF Station Initialize	50	750									
Earth Terminal Complex Station Initialize	50	750									
Journal Display Formatter	100	1500	X								
Fault File Search	75	1125		X	X	X					
Fault File Linkage Modification	150	2250				X					
Fault Filter	50	750		X							
Related Fault Record Manager	50	750		X	X	X					
Precedence Determine (N)	100	1500									
AUTOVON Trunk Translater	50	750									
ATEC Buffer Manager	100	1500									
Total Occupancy			6375	7125	5625	11625	11250	3750	750	750	750

Table 3.3-4 (Sheet 3). Node Functional Overlay Structure Sizing Summary

			SECTOR																	
PROGRAM NAME	NO. INST HOL	Program Occupancy (bytes)	Fault Notification Broadcast	Fault Update Broadcast	Fault Closure Broadcast	Node Fault Retrieval	Node Fault Destination	Node Fault Update	Fault Responsibility Acceptance	Connectivity Modification	Configuration Update	Node Reroute Destination	Reroute Confirmation	PMP/QA Data Destination	Manual Measure-ment Destination	Free Text Msg Processing				
Journal Inspection Processor (N)	275	4125																		
Fault Notification Broadcast Processor (N)	275	4125	X																	
Fault Update Broadcast Processor (N)	275	4125		X																
Fault Closure Broadcast Processor (N)	275	4125			X															
Broadcast Message Generator	200	3000																		
Node Fault Summary Processor	100	1500																		
Fault Record Retrieve (N)	100	1500																		
Node Fault Retrieval Processor	75	1125				X														
Node Fault Destination Processor	75	1125					X													
Node Fault Input Processor	400	6000																		
Node Fault Update	150	2250						X												
Fault Responsibility Accept	75	1125							X											
Station Fault Accept	100	1500																		
Station Fault Update	150	2250																		
Station Fault Close	200	3000																		
Connectivity Display Processor (N)	200	3000																		
Connectivity Modification Processor	500	7500								X										
Configuration Update Processor	50	750									X									
Node Reroute Destination Processor	50	750										X								
Reroute Confirmation Processor (N)	200	3000											X							
Media Status Retrieval Processor	250	3750																		
PMP/QA Request Processor	50	750																		
PMP/QA Data Accept	75	1125																		
PMP/QA Destination Processor	50	750												X						
Manual Measurement Request Processor (N)	50	750																		
Manual Measurement Accept	75	1125																		
Manual Measurement Destination Processor (N)	50	750													X					
Free Text Message Processor	50	750														X				
HAZCON Accept	100	1500																		

Table 3.3-4 (Sheet 4). Node Functional Overlay Structure Sizing Summary

PROGRAM NAME	NO INST HOL	Program Occupancy (bytes)	SECTOR: Fault Notification Broadcast	Fault Update Broadcast	Fault Closure Broadcast	Node Fault Retrieval	Node Fault Destination	Node Fault Update	Fault Responsibility Acceptance	Connectivity Modification	Configuration Update	Node Reroute Destination	Reroute Confirmation	PMP/QA Data Destination	Manual Measurement Destination	Free Text Msg Processing
Station Initialize	50	750														
Link Connectivity Retrieve	50	750														
VFCT Trunk Connectivity Retrieve	200	3000														
CCSD Connectivity Retrieve	200	3000														
Trunk Connectivity Retrieve	100	1500														
Link Connectivity Update	100	1500								X						
Trunk Connectivity Update	200	3000								X						
CCSD Connectivity Update	400	6000								X						
Station Equipment Update	100	1500								X						
VFCT Trunk Connectivity Update	400	6000								X						
Precedence Processor	400	6000	X	X	X											
Fault File Manager	150	2250	X	X	X	X	X	X	X				X			
Fault Summary Generator	50	750														
Associated Fault Purge	100	1500			X											
Detailed Fault Generator	75	1125														
Journal Output Manager	50	750														
AUTODIN Station Initialize	50	750														
AUTOVON Station Initialize	50	750														
AUTOSEVOCOM Station Initialize	50	750														
TCF Station Initialize	50	750														
Earth Terminal Complex Station Initialize	50	750														
Journal Display Formatter	100	1500														
Fault File Search	75	1125	X	X	X	X		X	X				X			
Fault File Linkage Modification	150	2250	X	X	X		X	X								
Fault Filter	50	750														
Related Fault Record Manager	50	750	X	X	X		X									
Precedence Determine (N)	100	1500	X	X	X											
AUTOVON Trunk Translater	50	750														
ATEC Buffer Manager	100	1500	X													
Total Occupancy			19500	18000	19500	4500	6375	7875	4500	25500	750	750	6375	750	750	750

Table 3.3-4 (Sheet 5). Node Functional Overlay Structure Sizing Summary

			STATION CONTROLLER																	
PROGRAM NAME	NO. INST HOL	Program Occupancy (bytes)	Node Fault Summarization	Node Fault Retrieval	Station Fault Accept	Station Fault Update	Station Fault Close	Connectivity Display	Reroute Confirmation	Media Status Retrieval	PMP QA Data Acceptance	Manual Measure-ment Request	Manual Measurement Acceptance	Free Text Msg Processing	HAZCON Acceptance	Station Initialization	ATEC	AUTOVON	AUTODIN	
Journal Inspection Processor (N)	275	4125																		
Fault Notification Broadcast Processor (N)	275	4125																		
Fault Update Broadcast Processor (N)	275	4125																		
Fault Closure Broadcast Processor (N)	275	4125																		
Broadcast Message Generator	200	3000			X	X	X								X		X	X	X	
Node Fault Summary Processor	100	1500	X																	
Fault Record Retrieve (N)	100	1500																		
Node Fault Retrieval Processor	75	1125		X																
Node Fault Destination Processor	75	1125																		
Node Fault Input Processor	400	6000			X															
Node Fault Update	150	2250																		
Fault Responsibility Accept	75	1125																		
Station Fault Accept	100	1500			X															
Station Fault Update	150	2250				X														
Station Fault Close	200	3000					X													
Connectivity Display Processor (N)	200	3000						X												
Connectivity Modification Processor	500	7500																		
Configuration Update Processor	50	750																		
Node Reroute Destination Processor	50	750																		
Reroute Confirmation Processor (N)	200	3000							X											
Media Status Retrieval Processor	250	3750								X										
PMP QA Request Processor	50	750																		
PMP QA Data Accept	75	1125									X									
PMP/QA Destination Processor	50	750																		
Manual Measurement Request Processor (N)	50	750										X								
Manual Measurement Accept	75	1125											X							
Manual Measurement Destination Proc (N)	50	750																		
Free Text Message Processor	50	750												X						
HAZCON Accept	100	1500													X					

Table 3.3-4 (Sheet 6). Node Functional Overlay Structure Sizing Summary

PROGRAM NAME	NO INST HOL	Program Occupancy (bytes)	STATION CONTROLLER: Node Fault Summarization	Node Fault Retrieval	Station Fault Accept	Station Fault Update	Station Fault Close	Connectivity Display	Reroute Confirmation	Media Status Retrieval	PMP QA Data Acceptance	Manual Measure-ment Request	Manual Measurement Acceptance	Free Text Msg Processing	HAZCON Acceptance	Station Initialization	ATEC	AUTOVON	AUTODIN
Station Initialize	50	750														X			
Link Connectivity Retrieve	50	750						X											
VFCT Trunk Connectivity Retrieve	200	3000						X											
CCSD Connectivity Retrieve	200	3000						X											
Trunk Connectivity Retrieve	100	1500						X											
Link Connectivity Update	100	1500																	
Trunk Connectivity Update	200	3000																	
CCSD Connectivity Update	400	6000																	
Station Equipment Update	100	1500																	
VFCT Trunk Connectivity Update	400	6000																	
Precedence Processor	400	6000			X												X	X	X
Fault File Manager	150	2250	X	X		X	X		X								X	X	X
Fault Summary Generator	50	750	X																
Associated Fault Purge	100	1500					X												
Detailed Fault Generator	75	1125			X														
Journal Output Manager	50	750																	
AUTODIN Station Initialize	50	750														X			
AUTOVON Station Initialize	50	750														X			
AUTOSEVOCOM Station Initialize	50	750														X			
TCF Station Initialize	50	750														X			
Earth Terminal Complex Station Initialize	50	750														X			
Journal Display Formatter	100	1500																	
Fault File Search	75	1125	X	X			X		X										
Fault File Linkage Modification	150	2250			X		X										X	X	X
Fault Filter	50	750	X																
Related Fault Record Manager	50	750	X			X	X												
Precedence Determine (N)	100	1500			X												X	X	X
AUTOVON Trunk Translater	50	750																	
ATEC Buffer Manager	100	1500																	
Total Occupancy			7125	4875	15000	9250	13875	11250	6375	3750	1125	750	1125	750	1500	4500	15000	15000	15000

Table 3.3-5. Determination of the Largest Memory Occupancy Requirement for the Node

Nodal Element	Resident Routines	Support Overlay	Largest Functional Overlay	Total Occupancy
Nodal Controller	55,350	32,925	11,625	99,900
Sector	55,350	34,050	25,500	114,900
Station Controller	55,350	30,675	15,000	101,025
ATEC	55,350	33,300	15,000	103,650
AUTODIN Report Proc	55,350	31,050	15,000	101,400
AUTOVON Module	55,350	31,800	15,000	102,150

Table 3.3-6. Summary of Algorithms for the Node

Algorithm	Function	# ASM Inst	# Disk Accesses
N1	Process Fault Notification Broadcasts from Sector	3490	28
N2	Accept Fault Entry from Stations	395	--
N3	Accept Fault Entry from AUTOVON Module	415	1
N4	Accept Fault Entry from AUTODIN Report Processor	480	1
N5	Accept Fault Entry from ATEC	415	1
N6	Perform Detailed Fault Entry Processing	3330	27
N7	Display CCSD Connectivity to Node Controller	18012	16

Table 3.3-7. Node I/O Load

Source	No. Lines	Line Rate (bps)	No. Byte Transfers (B/Sec/Line)	Aggregate Transfers/ Sec	Load Transfers (Inst)	Aggregate Load (Inst/Sec)
Sector	1 1/	2400	300	600 1/	3	1800
Stations	10	150	19	190	3	570
VON Module	1 1/	2400	300	600 1/	3	1800
DIN Report Proc	1	75	10	10	3	30
ATEC	1 1/	2400	300	600 1/	3	1800
Node Controller	1	2400	300	300	3	900
Total I/O Load - 6,900 Inst/Sec						

1/ Full Duplex

3.4 HARDWARE CONSIDERATIONS FOR THE NODE

In the following subsections the hardware considerations for the Node level of unified control including processor, peripheral equipment, and processor interface characteristics are addressed.

3.4.1 Node Processor

The Node processing system as described in Section 3.3 largely performs data base management and display processing functions. A basic characteristic of such functions is that they are highly I/O bound by disk and terminal access requirements as demonstrated by the load analysis presented in Paragraph 3.3.3. Taking the worst case functional load determined in this paragraph, and applying a task switch overhead of 1 millisecond/switch, the switching overhead can be estimated in the worst case to be 40 milliseconds (one switch for each message/request processed). The sustained Node processing load in a multiprogrammed environment can now be determined.

Depending upon the relative speed of the Node processor, this constitutes a varying absolute load. The loads for three classes of 16-bit word length minicomputers are summarized below:

8 microsecond average instruction time - 0.113

5 microsecond average instruction time - .071

2.5 microsecond average instruction time - .036

As can be seen from these loads, assuming a relatively low speed processor, the sustained real time load is on the order of 11.3 percent. At the rates suggested in this report processing speed is not a critical factor in accommodating the real time functions of the Node.

The processor memory requirement for the Node is estimated to be 116K bytes (Paragraph 3.3.2). The Node processor should at a minimum support a memory configuration adequate to satisfy this requirement.

In order to provide future functional expansion, the processor should provide for considerable memory expansion beyond the initial unified control requirement. Allowing 100 percent growth capability would place a maximum memory size requirement of 256K bytes on the Node processor. Memory cycle time should not exceed 1 microsecond.

Additional hardware requirements on the Node processor include a power fail/auto restart capability, hardware bootstrap loading, real time clock for time scheduled event control, and an operator control panel as an aid to field maintenance personnel.

The Node processor should also provide off-the-shelf interfaces for all of the required Node peripherals and communications interfaces described in the following paragraphs.

An important consideration for the Node processor is the availability of proven support software. This software should include a real-time disk operating system that supports multi-tasking, foreground/background, overlay supervision, random file management, buffering, and spooling. Software peripheral drivers should be available for the standard unified control peripherals. The processor should support interactive system control, interactive text editing, interactive debugging, and macro assembly. To minimize the memory requirements for the operational configuration, a relocatable dynamic loader is essential. In order to minimize software development costs it is necessary that the processor support a high order language with library support for bit manipulation, formatted input/output, and data conversion. Data base management software operational under the real time operating system and HOL compiler would be an effective substitute for the generic data base management software included with the Node software design. The use of data base management software would reduce the amount of applications code in the system by an amount varying with the power of the data base management package.

In order to minimize logistic problems (maintenance, spares provisioning) and to support expansion into future higher bandwidth applications at the Node, the processor should be a member of an upward compatible family of hardware.

3.4.2 Node Peripherals and Interfaces

Figure 3.4-1 shows the hardware configuration for the Node. The Node hardware complement includes a processor configured with a minimum of 128K bytes of main memory, 5M bytes of random access disk storage for data base and applications overlay storage, a magnetic tape storage device for long term journal retention, a KB/CRT with local printing capability to support the Node Controller position, and up to ten KB/CRT terminals with optional local printing capabilities to support the Station Controller positions.

Communications interfaces to the Node include three 2400 bps serial synchronous channels to support VON MODULE, ATEC, and Sector communications, and a 75 bps serial interface to the AUTODIN Report Processor.

The Node system is highly dependent on random data storage and retrieval. The data base requirement analysis in this report indicates that a minimum of 1.7M bytes of data is necessary for the Node data base. A 5M byte disk capacity accommodates these requirements and provides moderate expansion. Average access time for the disk should be less than 50 milliseconds because of the projected high disk utilizations. This disk should include a removable cartridge to facilitate configuration management, and the controller should support at least four disk drives to accommodate future expansion. A standard processor interface to the controller is necessary.

The magnetic tape unit should include a standard processor interface providing formatting logic, and DMA I/O operation. If batch analysis of journal data is desired and existing facilities are to be used to perform the analysis, consideration should be made for compatible tape recording formats.

Unified control functions involve a high degree of operation interaction and are dependent upon an operator input and output device that allows powerful operator interaction at minimal skill levels. An intelligent alphanumeric self-refreshed CRT display with keyboard is necessary for providing unified control interfaces to Node and Station Controllers.

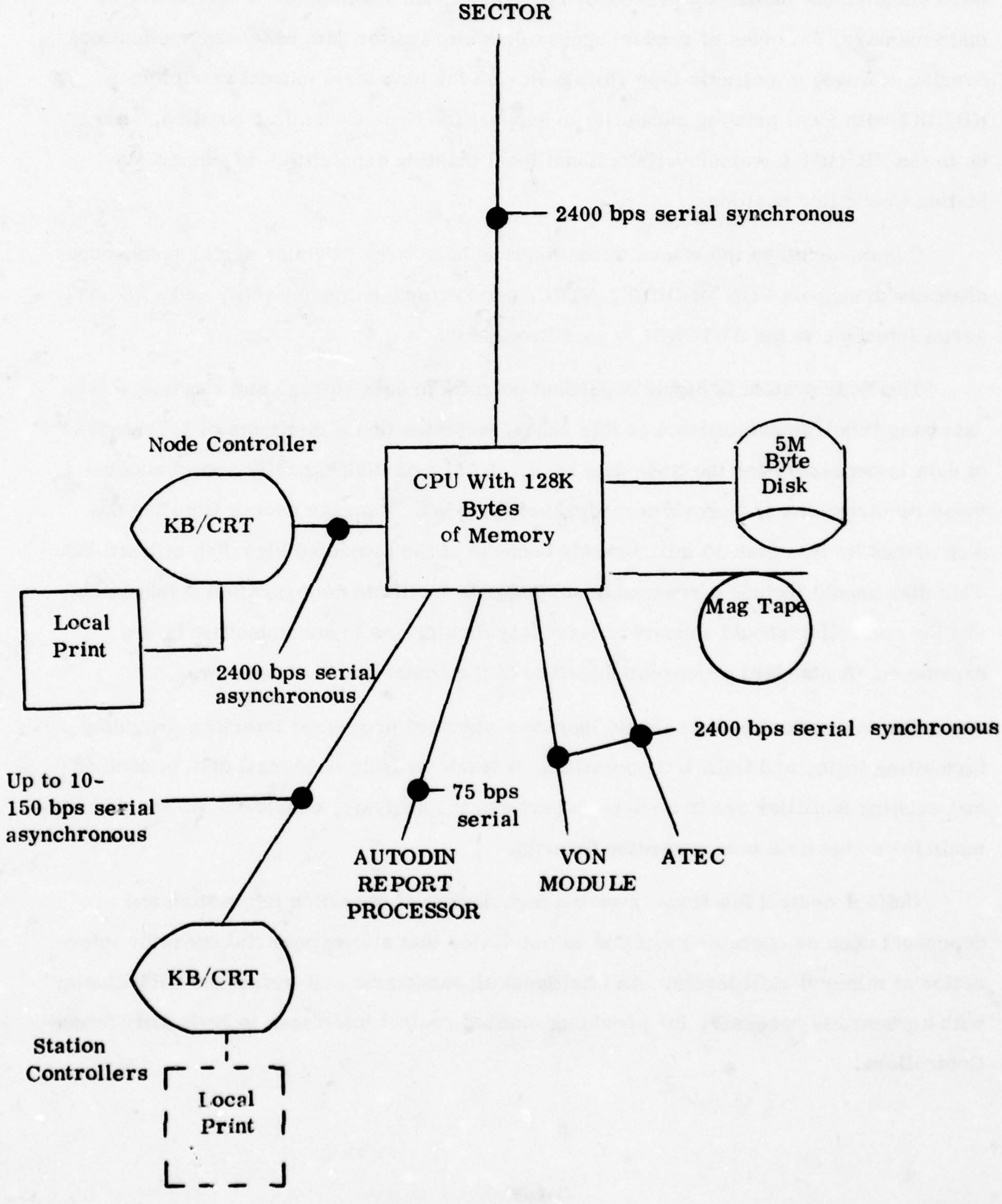


Figure 3.4-1. Node Hardware Configuration

The display should provide a viewing area of 24 80-character lines of text and should provide data highlighting such as underlining, variable intensity, reverse video, and character blinking. An audio alarm is required so that the operator can be alerted upon receiption of new data. The keyboard should have a standard typewriter format and should supply multiple user definable function keys. The terminal should have a character set including upper and lower alphanumeric characters and all ASCII control characters. The terminal should optionally operate synchronously and asynchronously at a data rate of at least 2400 baud using industry compatible interfacing standards. Block and character transmission capabilities should be supported to simplify interactive data entry. The terminal should have a self-test feature to support fault isolation.

In addition to the preceding requirements, it is desirable that the terminal support internal storage for multiple page displays. Protected fields and field tabulations are also desirable to simplify data entry. The terminal should also be capable of providing local hard copies of screen data. This capability should be provided to the Nodal Controller and selected Station Controllers in areas with significantly high concentrations of circuits.

The synchronous communications channels used for ATEC, VON, and Sector communications should provide full- and half-duplex operation at a minimum rate of 2400 baud with programmable sync character and programmable character size. The 2400 baud rate will allow a maximum fault notification message throughput of 10 messages/second assuming a 30 byte message. Since the average fault occurrence rate is much less than this amount for the entire DCS, the broadcast function is easily accommodated by this rate. The interface should also provide MODEM Control and compatability with industry standard synchronous MODEMS. Hardware error code generation and checking would be desirable to minimize processor line handling overhead.

SECTION 4 - SECTOR REQUIREMENTS

4.1 FUNCTIONAL DESCRIPTION

This functional description encompasses the functions performed at the sector level of its unified control system. In the detailed flowcharts that follow many connections between pages were required because of the complexity of the diagrams. A continuation to or from a different page is shown by a circle with a number in it. The numbering system is the same as that used on the general flowchart. ~~If a circle con-~~ tains S3-1 the flow continues on Sheet 3 of the sector level flowchart, the second number distinguishing different inputs on the same page. A single circle indicates the flow is information only, and two concentric circles indicate that the flow is control and direction as well as information.

The majority of the functions illustrated within the sector level are envisioned as being automatically processed. At several points, however, operator intervention is required. This is indicated within the flowcharts by the dashed lines.

Figure 4.1-1 is the functional flowchart for the sector. Sheet 1 shows the information distribution function that is performed by the sector to inform all parts of the network that are affected by any reported degradation. Information from the nodes within a sector A that concerns status information about a link, trunk, or circuit B first updates the sector data base C . The routine on Sheet 3 is initiated to examine the possibility of establishing a reroute if the problem is an outage. The information is also forwarded to the ACOC D .

The sector next determines if the report could affect any links, trunks, or circuits outside of the nodal area that reported the problem E . If not, the routine stops since the node is responsible for isolating the fault and will inform the sector when the status of the condition changes. If the affect does leave the reporting nodal area, the sector will distribute a fault notification to all of the other nodes which are possibly affected within the sector F . For example, if a node reports a trunk

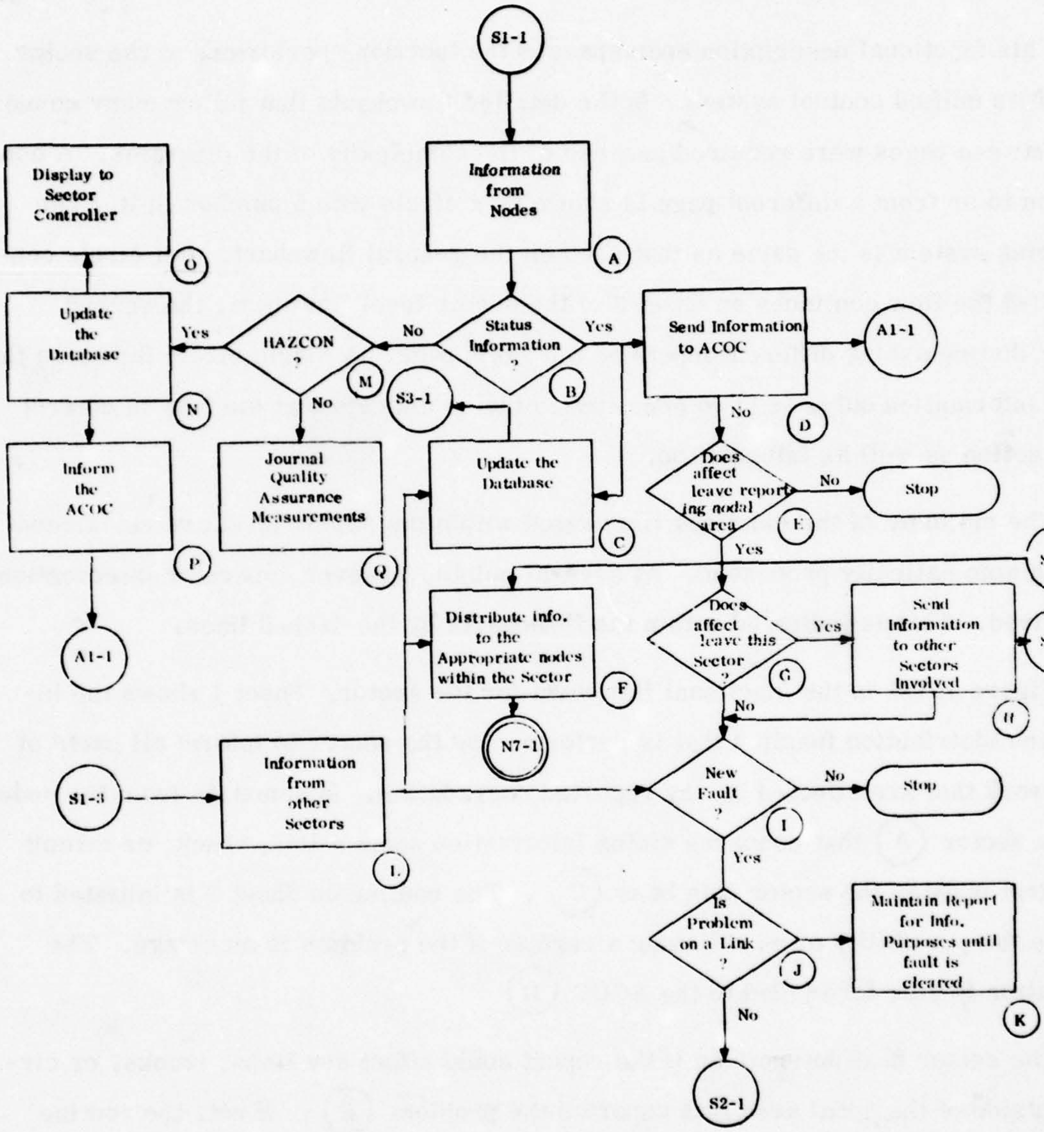


Figure 4.1-1. Sector Level Functional Flowchart (Sheet 1 of 3)

problem, all other nodes through which the trunk passes are informed of the fault. Also, any node that has a circuit which rides on that trunk at some point on its path, although the trunk itself is not in the nodal area, will be informed (F). If the nodal area reporting the fault does not contain the station responsible for manual fault isolation, the sector will also forward all of the detailed fault information to the nodal area that is responsible. At this point status information that was received from the ACOC concerning intertheater links, trunks, and circuits (entering at S1-2 from Sheet 3) also enters the routine and is distributed to the appropriate nodes. The reports are then examined to determine if any links, trunks or circuits could be affected outside of this sector (G). If so, information on the problem is sent to the other sectors involved (H). Detailed fault information is also sent to another sector if it contains the nodal area responsible for directing manual isolation on that particular fault.

Similar information received from other sectors (L) updates the sector data base (C), also initiating the reroute routine on Sheet 3, and is distributed to all of the nodes within the sector that may be affected by the problem (F). The information is then examined, as in the information originating within the sector (G) (H) to determine if it is a newly reported fault (I). If not, the routine stops, since the information will be an update or closure of a previously reported fault, and no further action is required by the sector beyond distributing the information. If it is a new fault, and the problem is on a link (J), the sector maintains the status of the problem, but takes no further action (K). In the case of link troubles the nodes responsible will automatically direct the terminating stations involved to coordinate for fault isolation. If the problem is not on a link (J), the fault isolation routine on Sheet 2 is initiated.

If the report from the node is not status information on a link, trunk, or circuit (B), it will be either quality assurance measurements or the report of a harzardous condition at a station. If it is concerning a hazardous condition (M), the information will be stored in the sector data base (N). The sector controller will be kept informed of HAZCON's within the sector by receiving displays of the information as it

is reported (O) . Information on hazardous conditions will also be forwarded to the ACOC (P) . If the information is quality assurance measurements (M) , the data will be journaled by the sector (Q) for reference at a later time.

Sheet 2 of the flowchart shows the fault isolation routine that is performed at the sector for trunk or circuit problems. First, the sector checks to see if any of the nodes involved are equipped with ATEC to monitor the trunk or circuit in question (A) . If not, and the problem is on a circuit (B) , the data base is examined to determine if the circuit should have a known signal level that could be monitored (C) . If it does, or if the problem is on a trunk (B) , the sector will send the indication to the appropriate nodes to proceed with the manual level check (D) . The nodes will return the results to the sector (entering at S2-2). If no problems were revealed at any of the nodes (E) , the sector will determine if the trunk or circuit is contained within the sector boundaries (F) . If not, and the nodal area containing the station responsible for manual fault isolation is in another sector (G) , this sector will inform the other sector that no problem was found (J) . If the responsible node is not in another sector (G) , this sector will wait for the results from the other sectors involved before proceeding. If the other sectors did not find a problem (I) , or the trunk or circuit is contained within this sector (F) , the sector will inform the responsible node to initiate manual fault isolation procedures (H) . If another sector did find a problem (I) , this sector will notify all of the appropriate nodes that the problem has been isolated to another sector (K) . The nodes will then stop any associated fault isolation that was in progress.

If one of the nodes does reveal a problem (E) , and reports that the problem is contained within its area (L) , the sector will notify the other nodes involved who will cancel their associated fault isolation (M) . If a problem is found, but no node can isolate it within its area (L) , all of the information from the nodes is displayed to the sector controller (N) . The controller will review the information to determine between which nodes the trouble must exist (O) . The sector will then instruct the appropriate notes to proceed with manual fault isolation (P) .

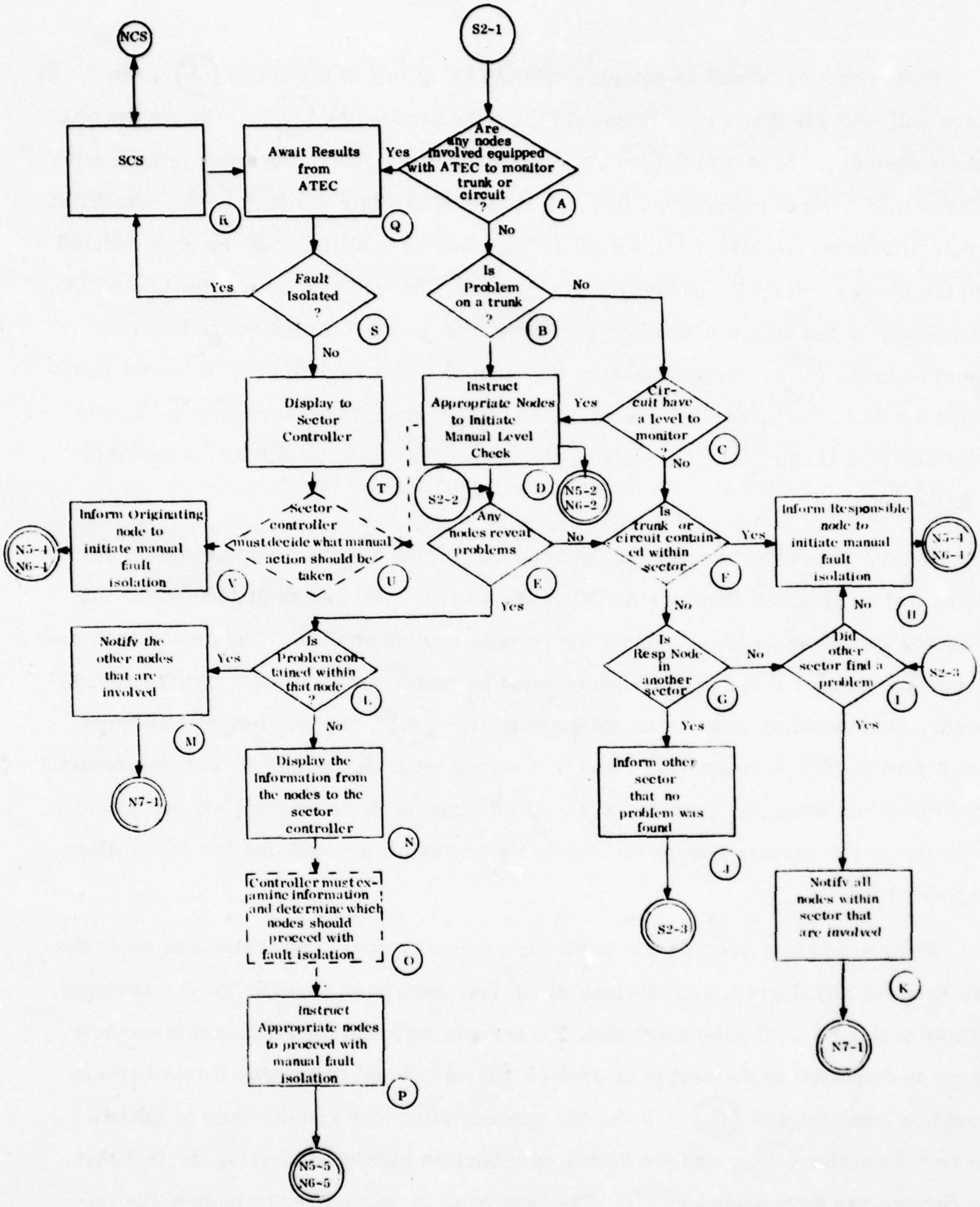


Figure 4.1-1. Sector Level Functional Flowchart (Sheet 2 of 3)

If the trunk or circuit is equipped with ATEC at any of the nodes (A) , the sector will wait for the results from ATEC before proceeding (Q) . The sector control subsystem (SCS) of ATEC (R) , as mentioned previously, functions independely of the unified control information flow. If ATEC can isolate the fault (S) , the ATEC structure informs the stations involved and the data base at the nodal level is updated with the results. If ATEC cannot isolate the fault, the information obtained by ATEC is displayed to the sector controller (T) who must decide on what manual actions should be taken (U) . Depending upon the number and distribution of the nodes equipped with ATEC, the controller can decide to either direct the other nodes to initiate a manual level check (D) , or instruct the responsible node to initiate manual fault isolation (V) .

Sheet 3 shows the reroute implementation routine and the distribution of information that is received from the ACOC at the sector. All new fault indications updating the data base on Sheet 1 enter the reroute routine at S3-1. The sector examines the new reports for three criteria which must be met to automatically initiate reroute actions. The problem must be an outage condition (A) , the trunk or circuit must have a preassigned reroute (B) , and this sector must be designated as being responsible for establishing the reroute (C) . If all three of these criteria are not met the sector stops the reroute routine and keeps the status of the condition for information purposes (D) .

If the conditions are met for initiating reroute actions, the sector examines the data base for any degraded indications which may have been reported on the assigned reroute path (E) . If none are found, the reroute path and the information on the outage is displayed to the sector controller (F) who must determine if this reroute should be implemented (G) . If so, the appropriate nodes are directed to initiate the reroute action (H) , and the sector data base is updated to include the fact that the reroute has been ordered (I) . The data base is not updated to include the implenentation of the reroute until the stations involved submit an update report saying that the reroute is established.

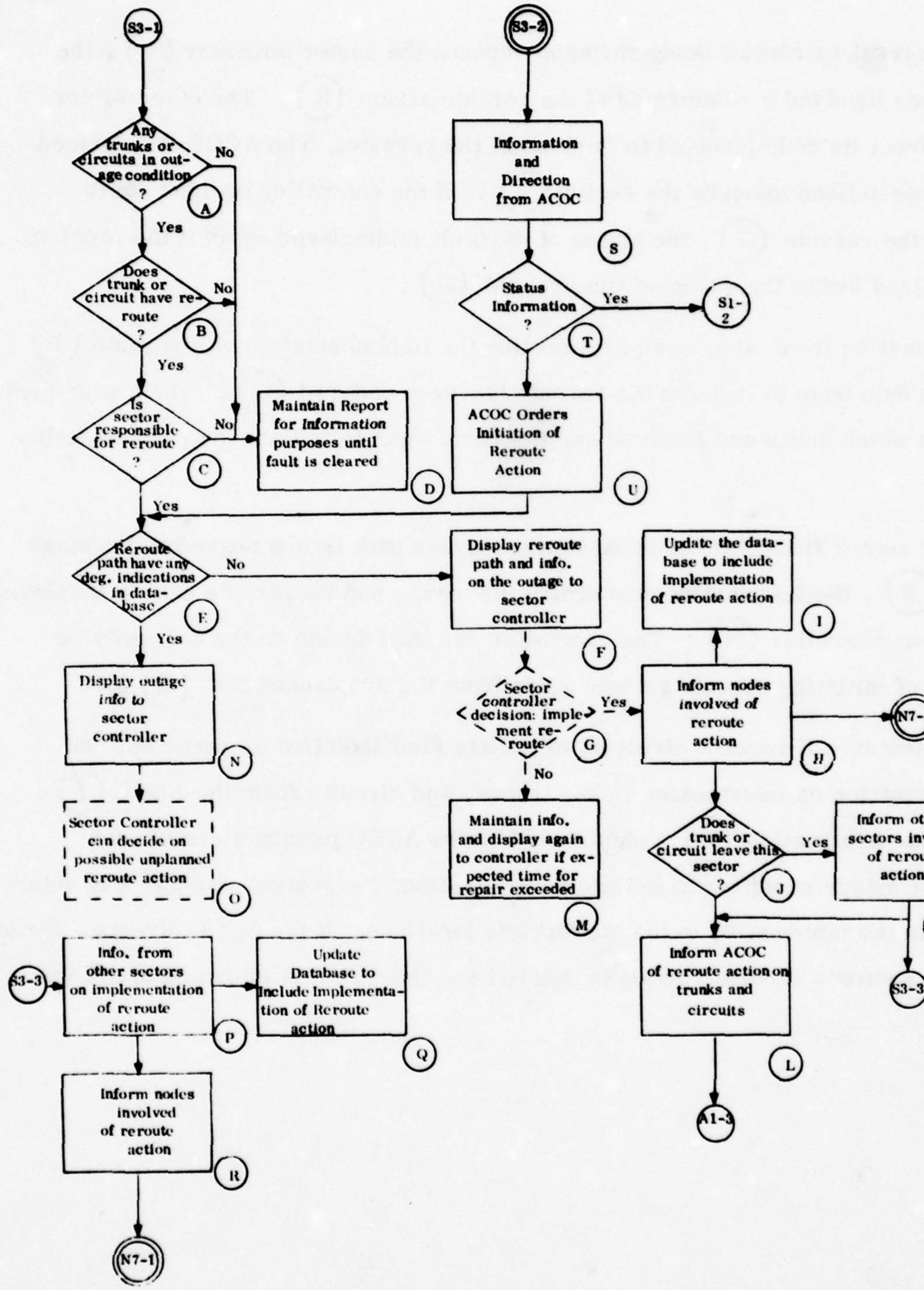


Figure 4.1-1. Sector Level Functional Flowchart (Sheet 3 of 3)

If the trunk or circuit being rerouted crosses the sector boundary (J), the other sectors involved are informed of the reroute action (K). The other sector will then direct its node involved to implement the reroute. The ACOC is informed of all reroute actions taken by the sector (L). If the controller decides not to implement the reroute (G), the status of the fault is displayed again if the problem is not repaired within the expected time period (M).

Information from other sectors directing the implementation of a reroute (P), updates the data base to indicate the reroute has been ordered (Q). The sector then determines which nodes are involved and instructs them to initiate the reroute action (R).

If the sector finds that the preassigned reroute path is in a degraded or outage condition (E), the information concerning the outage and its reroute path is displayed to the sector controller (N). The controller can then decide on the necessity or possibility of initiating reroute actions aside from the preplanned path (O).

The sector will receive direction to initiate fault isolation or reroutes, and status information on intertheater links, trunks, and circuits from the ACOC (S). If it is status information (T), which could be the ACOC placing a circuit in a degraded or outage condition to initiate fault isolation, the routine on Sheet 1 is entered to distribute the information to the appropriate locations. If the ACOC directs a reroute (U), the sector's reroute routine is entered and the ACOC is informed of the action taken.

4.2 SECTOR DATA BASE DESCRIPTION

The following paragraphs describe the Sector level data base in terms of its structure, content and sizing requirements.

4.2.1 Structure

In support of the unified control effort at the sector level, nine data files were created. These files include Sector, Node, Station, Link, Trunk and CCSD masters, a fault master and detail and a related fault detail. Figure 4.2-1 pictures graphically the data base structure. The linkages between data sets indicate that the detail data set can be accessed through master record parameters. In this case, a chain of fault detail records can be retrieved for each node, responsible station, link, trunk, CCSD or fault ID and a chain of related fault records can be read for each fault ID.

4.2.2 Content

Tables 4.2-1 through 4.2-9 describe the content and format of each data file within the Sector level data base.

The connectivity for each station, link, trunk and circuit within the theatre is provided in each of the respective master data files. A status summary or "degree of degradation" is also provided in these files. As faults are reported to the sector, these status files are updated with the current status. The detailed fault record, generated from a trouble report, is added to the Sector data base of the responsible station. Any additional trouble reports on the same problem will cause related fault file records to be added to the data base and linked to the detailed fault record.

Finally, directories of all Nodes under a Sector and Stations under a Node are provided in Sector and Node data files respectively.

4.2.3 Sizing

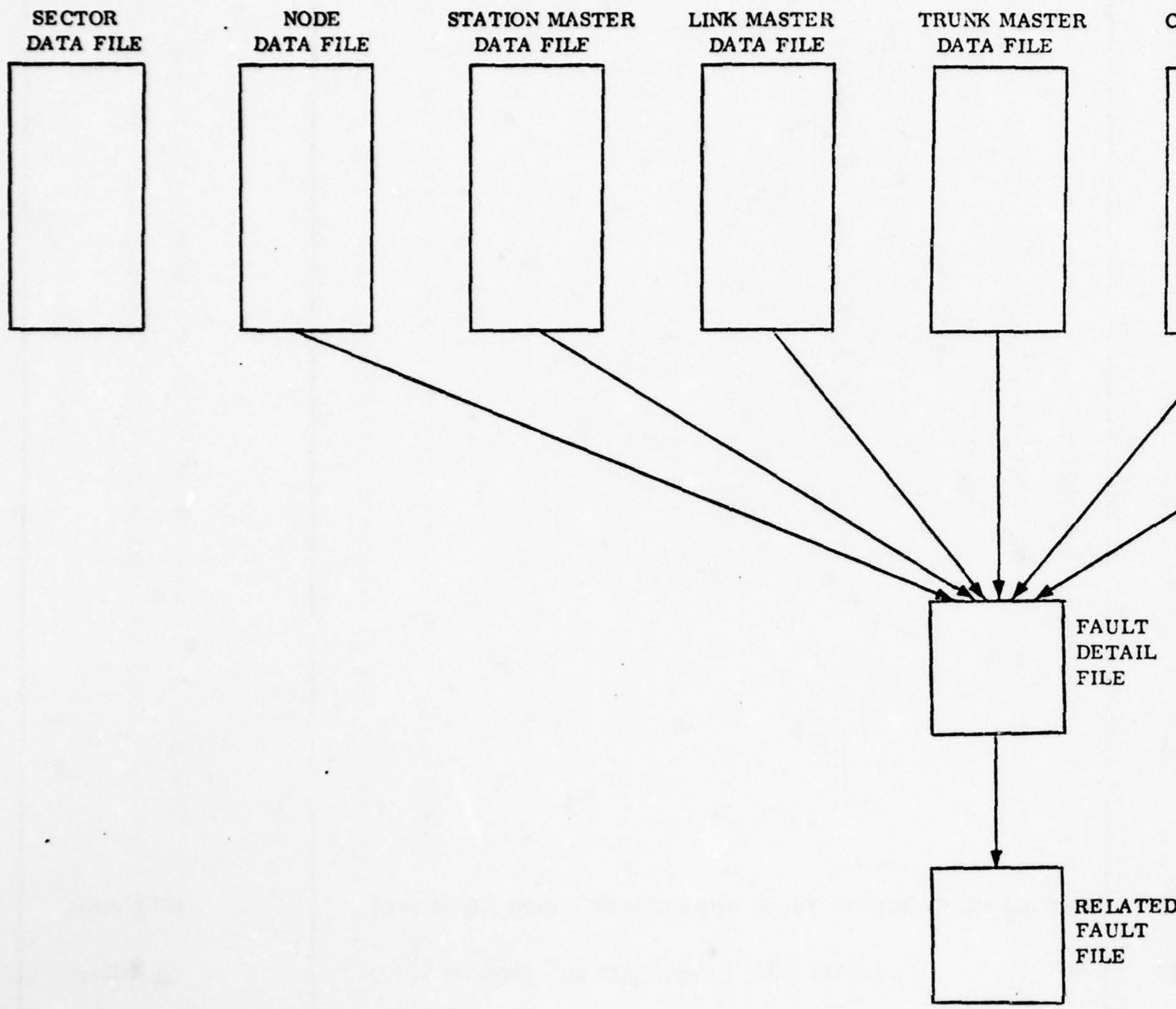
The sizing estimates for the Sector level data base are summarized in Table 4.2-10. The number of records contained within each data file was based on

the station, link, trunk and CCSD counts for the European theatre. These estimates were then increased by twenty five percent to allow for future expansion. In sizing the fault files the number of faults resident in the Node data base at any given time was estimated to be thirty percent of the total number of circuits. This figure was based on a study performed by Computer Sciences* in February 1971 on the Automated Quality Monitoring Reporting Subsystem (AQMRS) at Coltano Italy. This study showed that the AQMRS monitoring function identified twenty percent of the circuits monitored as being in a degraded condition. Since one of the sources for fault inputs is the ATEC system, which is considerably more powerful than the AQMRS, the figure of thirty percent was chosen for sizing.

The resulting disk space requirement for the Sector was estimated to be approximately 6.3 megabytes.

* Evaluation of USASTRATCOM Automated Quality Monitoring Reporting Subsystem (AQMRS), SCCC-TED-71-FR-22, Computer Sciences Corporation, February 1971.

SECTOR DATA BASE STRUCTURE



Note: The arrows indicate pointers within the Data File records allowing access to the detail or subordinate file records.

Figure 4.2-1. Sector Data Base Structure

Table 4.2-1. Sector Master Data File

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Sector ID	Code uniquely identifying a given sector.	ASCII	1
Node List	List of all nodes responsible to the sector (5 maximum).	ASCII	5
			Total = 6

Table 4.2-2. Node Master Data File

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Node ID	Code uniquely identifying a given node.	ASCII	1
Sector ID	Sector to which the node is responsible.	ASCII	1
Station List	List of all stations responsible to the node (16 maximum).	ASCII	48
Fault Detail Pointer	Pointer to the first record in the Fault Detail Data file that is associated with the given node.	Integer	1
			Total = 51

Table 4.2-3. Station Master Data File

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Station ID	Name uniquely identifying the station. This field consists of a three character site code and a three character type code such as "DIN" for an AUTODIN station or "TCF" for a manual tech control facility.	ASCII	3
Node ID	Node to which the station is responsible.	ASCII	1
Link List	List of all links at the station (16 maximum).	ASCII	48
ATEC Indication	Code indicating whether or not the station is equipped with ATEC monitoring equipment.	ASCII	1
HAZCON/Station Status Indication	Code indicating a HAZCON condition or station status.	ASCII	2
Fault Detail Pointer	Pointer to the first record in the Fault Detail Data File with the given station as the responsible station.	Integer	1
			TOTAL = 56

Table 4.2-4. Link Master Data File

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Link ID	Link Number	ASCII	3
Responsible Stations	Terminating stations for directions 1 and 2 of a given link.	ASCII	6
Trunk List	List of all DCS trunks on a given link (26 maximum).	ASCII	78
DOD (Direction 1)	Code indicating the degree of degradation in Direction 1 of the link.	ASCII	2
Isolation Flag (Direction 1)	Code indicating whether or not a fault in Direction 1 has been isolated.	ASCII	1
Fault ID (Direction 1)	Fault number assigned to a fault in Direction 1 of the link. Refer to the description of the Fault ID in the Fault Master Data File for the format of this field.	ASCII	3
DOD (Direction 2)	Code indicating the degree of degradation in Direction 2 of the link.	ASCII	2
Isolation Flag (Direction 2)	Code indicating whether or not a fault in Direction 2 has been isolated.	ASCII	1
Fault ID	Fault number assigned to a fault in direction 2 of the link. Refer to the description of the Fault ID in the Fault Master Data File for the format of this element.	ASCII	3
Fault Detail Pointer	Pointer to the first record in the Fault Detail Data File that is associated with the given link number.	Integer	1
			TOTAL = 100

Table 4.2-5. Trunk Master Data File (Sheet 1 of 2)

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Trunk ID	Trunk Number	ASCII	3
Responsible Stations	Terminating stations for directions 1 and 2 of a given trunk.	ASCII	6
VFCT CCSD	CCSD number (for VFCT trunks only).	ASCII	4
CCSD List	List of all CCSD's on a given trunk (32 maximum)	ASCII	128
Connectivity	Trunk connectivity list consisting of the nodes, stations, links, supergroups and groups that the trunk is routed over. The list will also indicate how the trunk appears at each station, i.e., VF termination, thru group, IF repeater, etc. In the example below, a trunk begins at LKF (node 01) manual tech control facility is thru-grouped at DON (node 2) and terminates at PMS. Node Type Direction Station Link SG G 01 V T LKFTCF M0671 02 3 02 G T DONTCF M0724 04 5 02 V R PMSTCF 00000 00 0	ASCII	180
Reroute ID (Preplanned)	Preplanned reroute trunk number. When alt-routing a trunk, the new connectivity can be found in the Trunk Master record for the trunk listed in this field.	ASCII	3
Reroute ID (Unplanned)	Rerouted trunk ID for those alt-routes employing a trunk other than the preplanned trunk. The new connectivity can be found in the Trunk Master record for the trunk listed in this field.	ASCII	3
Reroute Flag	Indication that the given trunk has been alt-routed.	ASCII	1

Table 4.2-5. Trunk Master Data File (Sheet 2 of 2)

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
DOD (Direction 1)	Code indicating the degree of degradation in Direction 1 of the trunk.	ASCII	2
Isolation Flag (Direction 1)	Code indicating whether or not a fault in Direction 1 has been isolated.	ASCII	1
Fault ID (Direction 1)	Fault number assigned to a fault in Direction 1 of the trunk. Refer to the description of the Fault ID in the Fault Master Data File for the format of this field.	ASCII	3
DOD (Direction 2)	Code indicating the degree of degradation in Direction 2 of the trunk.	ASCII	2
Isolation Flag (Direction 2)	Code indicating whether or not a fault in Direction 2 has been isolated.	ASCII	1
Fault ID (Direction 2)	Fault number assigned to a fault in Direction 2 of the trunk. Refer to the description of the Fault ID in the Fault Master Data File for the format of this field.	ASCII	3
Fault Detail Pointer	Pointer to the first record in the Fault Detail Data File that is associated with the given trunk number.	Integer	1
			TOTAL = 341

Table 4.2-6. CCSD Master Data File (Sheet 1 of 2)

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
CCSD Number	Circuit Number	ASCII	4
Restoration Priority	Restoration priority of the given circuit.	ASCII	2
CCSD Type	Code indicating the traffic type on the circuit, i.e., VON IST, DIN IST, etc.	ASCII	2
VFCT Trunk Number	VFCT Trunk associated with the circuit (for VFCT CCSD's only)	ASCII	3
Connectivity	Circuit connectivity list consisting of the trunk and channel numbers over which the circuit is routed. In the example below, a circuit is routed over two trunks using Channel 10 of the first and channel 2 of the second. 44JMB1/10, 45CMA2/02	ASCII	150
Reroute ID (Preplanned)	Preplanned reroute circuit number. When alt-routing a circuit, the new connectivity can be found in the CCSD master record for the circuit listed in this field.	ASCII	4
Reroute ID (Unplanned)	Rerouted CCSD number for those alt-routes employing a CCSD other than the preplanned CCSD. The new connectivity can be found in the CCSD Master Record for the circuit listed in this field.	ASCII	4
Reroute Flag	Indication that the given circuit has been alt-routed.	ASCII	1
DOD (Direction 1)	Code indicating the degree of degradation in Direction 1 of the circuit.	ASCII	2

Table 4.2-6. CCSD Master Data File (Sheet 2 of 2)

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Isolation Flag (Direction 1)	Code indicating whether or not a fault in direction 1 has been isolated.	ASCII	1
Fault ID (Direction 1)	Fault number assigned to a fault in direction 1 of the circuit. Refer to the description of the Fault ID in the Fault Master Data File for the format of this field.	ASCII	3
DOD (Direction 2)	Code indicating the degree of degradation in Direction 2 of the circuit.	ASCII	2
Isolation Flag (Direction 2)	Code indicating whether or not a fault in Direction 2 has been isolated.	ASCII	1
Fault ID (Direction 2)	Fault number assigned to a fault in Direction 2 of the circuit. Refer to the description of the Fault ID in the Fault Master Data File for the format of this field.	ASCII	3
Fault Detail Pointer	Pointer to the first record in the Fault Detail Data File that is associated with the given circuit number.	Integer	1
			TOTAL = 183

Table 4.2-7. Fault Master Data File

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Fault ID	Code uniquely identifying each fault reported within the system. The first two characters of this field will consist of the Node ID to which the problem was first reported. The last four characters will be the the next number in a sequential list of unassigned numbers.	ASCII	3
Link, Trunk or CCSD Number	The link, trunk or circuit on which the fault was reported.	ASCII	4
Fault Detail Pointer	Pointer to the record in the Fault Detail Data File that is associated with the given fault.	Integer	1
			TOTAL = 8

Table 4.2-8. Fault Detail Data File (Sheet 1 of 3)

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Fault ID	Fault number assigned to the trouble report initially entered on a link, trunk or circuit. This number will be the same as that contained in the Fault Master Data record.	ASCII	3
Reporting Station	Station where the initial link, trunk, or circuit trouble report was entered into the system.	ASCII	3
Fault Severity	Code indicating the type of fault, i.e., link, trunk or circuit.	ASCII	1
DTG of Report	Date-time group when the trouble report was generated.	ASCII	4
Link, Trunk or CCSD	The link, trunk or circuit number associated with the specified trouble report.	ASCII	4
Direction	Direction on which the fault was reported.	ASCII	1
RFO	Code indicating the reason for outage.	ASCII	2
ETR	Estimated time to repair the problem.	ASCII	4
In/Out Station	Code indicating whether the reporting station is actually reporting for another station.	ASCII	1
Pre-emption Flag	Flag indicating that fault isolation was stopped on this fault because it may have been caused by some higher order fault.	ASCII	1
DOD	Code indicating the degree of degradation reported on the link, trunk or CCSD.	ASCII	2
Isolation Flag	Code indicating whether or not the fault has been isolated.	ASCII	1

Table 4.2-8. Fault Detail Data File (Sheet 2 of 3)

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Alt-Route Flag	Code indicating whether or not the trunk or CCSD with the reported fault has been alt-routed.	ASCII	1
DTG of Alt-Route/ Restoral	Data-time group that the trunk or circuit was alt-routed and service restored to the user.	ASCII	4
DTG of Repair	Date-time group the problem was repaired and the fault closed.	ASCII	4
Responsible Station	Station responsible for closing the fault. This station is determined to be the terminating station for a given direction of a link, trunk, or circuit.	ASCII	3
Restoration Priority	Restoration priority of the circuit associated with the fault (if applicable).	ASCII	1
Remarks	Comments made by the operator when entering the trouble report.	ASCII	40
Related Fault Pointer	Pointer to the first record in the related fault file that is associated with the given fault ID.	Integer	1
Fault Detail Pointer	Pointer to the next record in the Fault Detail Data file that is associated with the given link number (if applicable).	Integer	1
Fault Detail Pointer	Pointer to the next record in the Fault detail data file that is associated with the given trunk number (if applicable).	Integer	1
Fault Detail Pointer	Pointer to the next record in the Fault Detail Data file that is associated with the given circuit number (if applicable).	Integer	1

Table 4.2-8. Fault Detail Data File (Sheet 3 of 3)

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Fault Detail Pointer	Pointer of the next record in the Fault Detail Data file that contains a pre-empted lower order fault.	Integer	1
Fault Detail Pointer	Pointer to the next record in the Fault Detail Data file that is associated with the given responsible station.	Integer	1
Fault Detail Pointer	Pointer to the next record in the Fault Detail Data file that is associated with the given node.	Integer	1
			TOTAL = 87

Table 4.2-9. Related Fault File

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Fault ID	Fault ID assigned to a trouble report on a given link, trunk or circuit. Should more than one report be sent to the node, they will be assigned the same Fault ID as the original report and stored in the Related Fault Detail Data File.	ASCII	3
Link, Trunk or CCSD	Link, trunk or circuit associated with the given fault.	ASCII	4
DTG of Report	Date-time group of trouble report.	ASCII	4
Reporting Station	Station reporting the fault.	ASCII	3
Related Fault Pointer	Pointer to the next record in the Related Fault File that is associated with the same Fault ID.	Integer	1
			TOTAL = 15

Table 4.2-10. Sector Level Data Base Sizing

DATA FILE NAME	RECORD SIZE (WORDS)	NUMBER OF RECORDS	FILE SIZE Words	Bytes
SECTOR MASTER	6	4	24	48
NODE MASTER	51	20	1,020	2,040
STATION MASTER	56	300	16,800	33,600
LINK MASTER	100	410	41,000	82,000
TRUNK MASTER	341	1,250	426,250	852,500
CCSD MASTER	183	12,500	2,287,500	4,575,000
FAULT MASTER	8	3,600	28,800	57,600
FAULT DETAIL	87	3,600	313,200	626,400
RELATED FAULT DETAIL	15	3,600	54,000	108,000
TOTAL			3,168,594	6,337,188

4.3 SOFTWARE CONSIDERATIONS FOR THE SECTOR

A preliminary software design for the Sector has been performed using the THREADS design methodology. This process is described in detail in Section 1.4. In the following subsections a detailed software design for the Sector level of unified control is presented in terms of the THREADS (identified during the design effort) to support the functional capabilities discussed in Section 4.1.

For each Sector function a THREAD flow diagram which describes the processing steps required in accomplishing the function and the routines supporting each processing step is presented. A sizing analysis is then provided which addresses individual routine size requirements as well as overall Sector processing system size requirements including estimates of lines of code and memory occupancy. Processor memory requirements are then addressed including support software, resident data structures and overlay techniques. A parametric processing load analysis is provided which shows processor and disk load requirements for the Sector as a function of various system event occurrence rates. Finally, the general characteristics of processor support software as they pertain to the Sector level of unified control are discussed.

4.3.1 Sector Software Design

The following paragraphs present a software system design for the Sector in terms of 52 Sector level THREADS. These THREADS are derived from the Sector level requirements presented in Section 4.1, where each THREAD supports a specific functional requirement. The THREADS are first presented in a hierarchical structure which shows all software capabilities available to each functional element of unified control at the Sector level. Each THREAD is additionally described in a THREAD flow diagram which shows the discrete processing requirements and individual routines necessary to accomplish the prescribed function. Finally, all routines identified in the THREAD flow diagrams are summarized in a hierarchical computer program structure showing the various levels of control within the applications software system.

4.3.1.1 Sector THREADS

Figure 4.3-1 summarizes the THREADS which comprise the Sector level of unified control. The figure shows a two-level hierarchy of THREADS supporting each operational element serviced by the Sector including the Sector Controller, other Sectors, Nodes, and the ACOC.

The top level of the hierarchy performs I/O and preliminary message processing functions. The software represented by these THREADS performs line handling, buffer management, and task scheduling activities. The stimulus to these THREADS is generally an interrupt or other condition indicating a call for input or output service, while the response is a completed I/O operation with appropriate subsequent processing scheduled. Each subsequent processing task is supported by a distinct THREAD located on the second level of the hierarchy. The scheduling activities performed by the top level THREADS serve as the stimulii to the various second level THREADS.

The second level THREADS are grouped into four subtrees corresponding to the four sources of external stimulus to the Sector. These groups are mapped to the top level THREAD they support by the connectors G through J on the first sheet of the figure. To examine the support available to a given Sector element it is necessary only to inspect the corresponding subtree for that element.

The THREADS contained in Figure 4.3-1 are presented in an abbreviated format. In the next paragraph each THREAD will be expanded into a flow diagram in order to show the detailed processing requirements and associated software requirements to accomplish the function supported by the THREAD.

4.3.1.2 THREAD Flow Diagrams

Figures 4.3-3 through 4.3-7 show the detailed flow diagrams for the Sector level THREADS. Each figure contains the diagrams for all THREADS which support a given Sector element. Table 4.3-1 summarizes the contents of these figures.

The basic format of the flow diagram is shown in Figure 4.3-2. The stimulus and response information will be the same as indicated in the abbreviated formats used in the THREAD hierarchy. However, while the processing information is summarized in the abbreviated format, it is expanded into a series of more precise steps in the flow diagram. Each step also lists the computer programs necessary to support the indicated processing.

The supervisory level and I/O diagrams are shown in Figure 4.3-3. These THREADS divide into two basic types. The first four THREADS address input processing of data from each unified control element which communicates directly with the Sector. In addition to input handling functions they perform supervisory scheduling functions based on the message types that are received. The remaining three THREADS perform communications output handling for the ACOC, Node, and Sector interfaces.

Figure 4.3-4 shows the THREAD diagrams which provide support to the Sector Controller position. Many of the requests that can be made from this position are identical with Node and Station Controller requests and utilize common software. Among the types of data that may be requested are media status, detailed fault record information, connectivity, journal contents, and summaries of outstanding faults. The Sector Controller also has the capability to update fault reports as a result of isolation activities he has performed, or assign responsibility for further fault isolation to the terminating station in the event he is unsuccessful from the controller position in isolating a fault.

During the course of fault isolation the Controller may request that automated and/or manual fault isolation measurements be performed and reported back to his position. Additionally, he may request the engagement of a reroute plan. This request is automatically forwarded to the ACOC for authorization and then distributed to the implementing stations.

Figure 4.3-5 shows the Node handling software. The majority of the messages received from the Node are of three general types: responses to requests for data from the Node and Station levels, requests to supply data to the Node and Station levels, and fault related broadcast messages.

Additional messages are provided for maintaining data base integrity including connectivity modification and reroute confirmation messages. In these two cases, the data base is not updated until confirmation of the modification has been made by the responsible element.

Figure 4.3-6 shows the ACOC handling software. In addition to the standard request servicing messages, several control directive messages are received from the ACOC. These messages include reroute implementation and configuration modification directives issued by the ACOC controller.

The Sector message handling software is shown in Figure 4.3-7. All of the messages supported by this package pertain to fault broadcast handling, or data request/response movement.

In the next paragraph, all of the computer programs which are identified in Figures 4.3-3 through 4.3-7 are presented in a computer program hierarchy in order to show the relationships of the various routines and to summarize the applications software system for the Sector.

4.3.1.3 Computer Program Hierarchy

All of the routines which are identified in the Sector level THREADS have been structured into a six-level program hierarchy. In determining the appropriate level for a given routine, two guidelines are followed. First, a given routine may call only those routines which reside at lower hierarchical levels. The application of this rule ensures that the levels of the hierarchy indicate the various levels of control within the software system. Second, each level of the hierarchy should be functionally homogeneous. That is, routines which perform similar functions should be grouped at a given hierarchical level.

Figure 4.3-8 shows the program hierarchy for the Sector level of unified control.

The top level of the hierarchy contains the Sector SUPERVISOR which controls execution of all scheduled events in the software system.

The second level contains the interrupt driven I/O drivers and a series of message processors. Each message processor controls the support activities for one of the major input sources at the Sector. In general, these routines supervise message decoding/validation and perform overlay retrieval.

The third level of the hierarchy contains the routines responsible for performing major operational functions. Such functions include processing individual Controller, Sector, Node, and ACOC message types.

The fourth level provides significant support functions to the various third level routines. For example, the third level Sector CONNECTIVITY DISPLAY PROCESSOR depends heavily on the four connectivity RETRIEVAL routines on this level. This amount of functional support minimizes duplication of software between the various operational function routines on the third level. In addition, it provides a level of insulation between the functionally oriented routines in the upper levels and the various data base structures employed in the lower levels of the hierarchy.

The fifth level consists largely of file managers for the various components of the data base. These file managers rely heavily on the sixth level generic data base management support routines FIND, GET, CREATE, DELETE and MODIFY for access to the various files. Additional system support activities supplied on the sixth level include error processing, message type decoding and I/O buffer management.

4.3.2 Software Sizing

The following two paragraphs present a software sizing analysis for the Sector. In the first paragraph, each routine identified during the design effort is addressed in terms of estimated lines of code and program and data occupancy requirements. The second paragraph then presents Sector processor memory requirements based on a two-level overlay structure.

4.3.2.1 Program Sizing

The sizing of the programs presented in this paragraph is based on an estimation of the number of lines of HOL code required to implement each routine in the

Sector program hierarchy (Paragraph 4.3.1.3), plus additional memory required to accommodate data for each routine. This sizing includes applications software and operating system enhancements only and assumes that the host computer supplies support software capabilities as described in 4.3.4.

Table 4.3-2 summarizes the program sizing for the Sector. The program occupancy for each routine is based on an expansion factor of 15 bytes of storage for each line of HOL. This ratio is typical of 16-bit word length machines using currently available HOL compilers. Further justification of this expansion ratio is provided in Section 1.4. Where applicable, the data occupancy for each routine includes buffer and table space requirements. Without the use of overlays, the total memory requirement for the Sector applications software is 192K bytes.

4.3.2.2 Processor Memory Requirements

The software system described in Section 4.3.1 is functionally partitionable and is susceptible to incorporation into an overlay structure. The use of overlays, where on-line secondary storage capabilities are available, minimizes processor memory requirements by retaining low demand software in secondary storage.

An overlay structure for the Sector software was developed by dividing the routines contained in the Sector program hierarchy into three categories: resident, element support and functional support.

The resident routines are high demand routines which support supervisor/control of all processing functions. Such routines as the SECTOR SUPERVISOR, the I/O drivers, the generic data base access routines, buffer managers, display handlers, and the destination processors are considered in this category since they are used to support multiple elements and many of the functional routines. Table 4.3-3 summarizes the resident routines for the Sector. These routines require 78,425 bytes of memory.

The routines which compose the support overlay are also summarized in Table 4.3-3 according to the operational element which they support. The positions and their respective support sizes are summarized below:

Sector Controller Support	9,000 bytes
Sector Support	7,875 bytes
ACOC Support	12,375 bytes
Node Support	10,875 bytes

The routines which are used for supporting an operational element are defined to be those routines that would be needed by any of the functional routines supporting the given element.

The routines comprising the functional overlays for the Sector Controller, Sector, ACOC, and Node are summarized in Table 4.3-4. Depending on the function to be performed, only one of these overlays would be in memory at any time.

In order to determine the amount of memory required at the Sector for applications software, it is necessary to add the memory requirements for the resident routines, support overlay routines and the largest functional overlay module for each Sector element. Table 4.3-5 shows that the largest memory requirement occurs for processing Node input. In this case the applications software requires 111,800 bytes of main memory.

In addition to the applications software requirements, the processor memory must accommodate the resident portion of a disk-based operating system. Based upon currently available real-time operating system software, a residency requirement for an operating system providing the support outlined in Section 3.3.4 is 12,000 bytes. This does not include occupancy within the operating system for the I/O drivers and buffer areas which were sized as part of the applications software. The total Sector memory requirements is now determined to be 124K bytes.

4.3.3 Sector Processing Load

A worst case sustained load analysis for the Sector is presented in this paragraph. Both processor and disk utilizations are considered because of the large amount of data base access activity required to support unified control functions. The utilizations are parametrically derived and presented in a series of curves which show utilization as a function of the rate of Node, Sector, and ACOC fault notification.

Table 4.3-6 summarizes the set of worst case algorithms on which the load analysis is based. Each algorithm is analyzed for the number of assembly language instructions executed and the number of disk accesses performed for a single execution of the algorithm. The flowcharts and detailed analysis of these algorithms are contained in Appendix A to this report.

Algorithms S1, S2 and S3 perform fault notification broadcast processing for messages received from other Sectors, the ACOC, and Nodes respectively. Algorithm S4 is the worst case display request that can be made from the Sector Controller position. This algorithm will be used later in this paragraph to establish average and worst case operator response times.

Table 4.3-7 shows the derivation of the worst case I/O support load. For each element interfaced at the Sector the maximum aggregate bandwidth is computed in terms of the number of assembly level instructions required per second to effect the I/O transfers. For the worst case it is assumed that data will be passed a character at a time on the processor I/O bus. From this table the I/O load at the Sector is 18,900 instructions/sec.

Figure 4.3-9 presents the derivation of the processing load at the Sector.

From Equation (1) it is seen that the total processing load is the sum of the loads supporting Node (P_{NODE}), Sector (P_{SECTOR}), and ACOC (P_{ACOC}) fault notifications, cycle stealing due to disk DMA operation (P_{DISK}) and communications I/O ($P_{I/O}$). Equation (2) shows that the fault notification processing loads are the produces of the single occurrence loads and occurrence rates. Equations (3), (4) and (5) show the computation of the single occurrence loads for Node, Sector, and ACOC fault notification respectively. Since the sustained load will be computed for a one minute interval, a time conversion factor must be included to find the effective average second load. Equation (6) accounts for memory cycle stealing due to the disk DMA activity. An average disk access size of one 256 word block is assumed. Equation (7) shows the communications I/O load. The worst case I/O load as presented in Table 4.3-7 is assumed. By rewriting Equation (2), Equation (8) now shows the Sector processing

load as a function of the rate of fault notification from the other system elements. This equation is plotted in Figure 4.3-10 for values of R_{NODE} from 0 to 60, R_{SECTOR} from 0 to 20, and R_{ACOC} from 0 to 20.

Figure 4.3-11 shows the derivation of the disk load at the Sector. Equation (1) shows that the total disk load is the sum of the disk loads supporting fault notification processing for the Node, Sector, and ACOC elements. These quantities are a function of the rate of fault related event occurrence as shown in Equation (2). Equation (6) shows the total disk load as a function of these occurrence rates. Figure 4.3-12 plots D_S as a function of R_{NODE}, R_{SECTOR}, and R_{ACOC}. The 100 percent utilization line for a typical moving head disk with sufficient capacity to accommodate the Sector data base is also indicated on this figure. The utilization threshold is based on a 50 millisecond average access time.

It is seen from the projected processor and disk loads that the nature of unified control processing at the Sector is highly I/O bound. Disk utilization is therefore the critical factor in accommodating a worst case situation.

Consider the case where the following unique faults are reported from the station level at an average Node within a one minute period:

ATEC	5	
Stations	8	(assume 8 stations at average Node)
Switch Faults	2	
	15	

Assuming five Nodes within the Sector area this amounts to 75 faults during the worst case minute. Assume further that 60 percent of these faults are unique and require reporting to the sector. This presents a Node fault notification rate (R_{NODE}) of 45 faults/minute. At this rate up to 20 Sector fault notifications and 5 ACOC notifications can be received before disk saturation occurs for a 50 millisecond average access time device.

The average load on the Sector processor and disk is considerably less since the words case Node fault rate discussed above could not be sustained in view of the average daily fault rate experienced in Europe.

Algorithm S4 can be used to determine operator response times as a function of the relative load on the Sector processor and disk. The algorithm requires that 18,012 instructions and 16 disk accesses be performed. The response time will be dominated by disk access time. The disk activity, assuming no contention for disk resources would require 800 milliseconds (16 accesses @ 50 milliseconds/access).

Assuming a relatively slow processing capability (8 microsecond average instruction time) the processing would require 144 milliseconds (no contention).

The total time until the connectivity request processing is completed and the data is ready for display is then .944 seconds when no other activity is ongoing.

Assuming that the Sector is processing 45 Node level, 20 Sector level, and 5 ACOC level fault notifications the response time for this request then degrades to 2.16 seconds (1.80 seconds total for disk, .360 seconds for processing).

4.3.4 Support Software

The operational and development software capabilities required to support Sector processing functions are similar to the capabilities described for the Node. This similarity is due to the high degree of functional commonality between all levels of unified control. For a description of the support software requirements see Section 3.3.4.

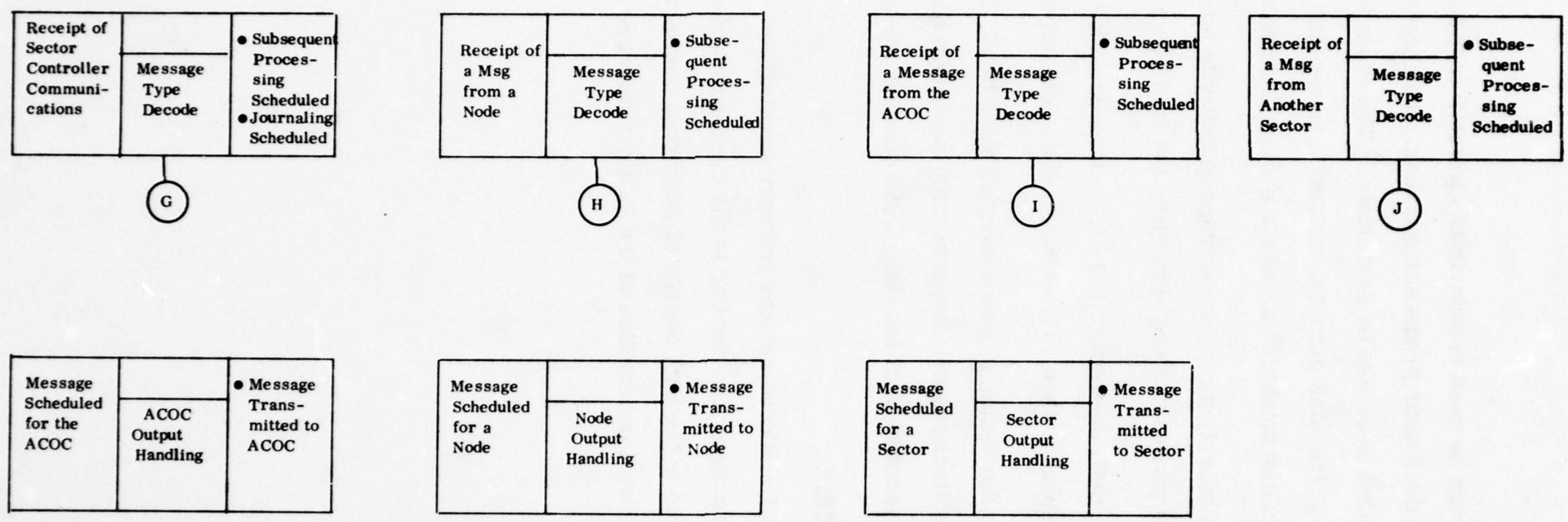


Figure 4.3-1. Sector Threads (Sheet 1 of 5)

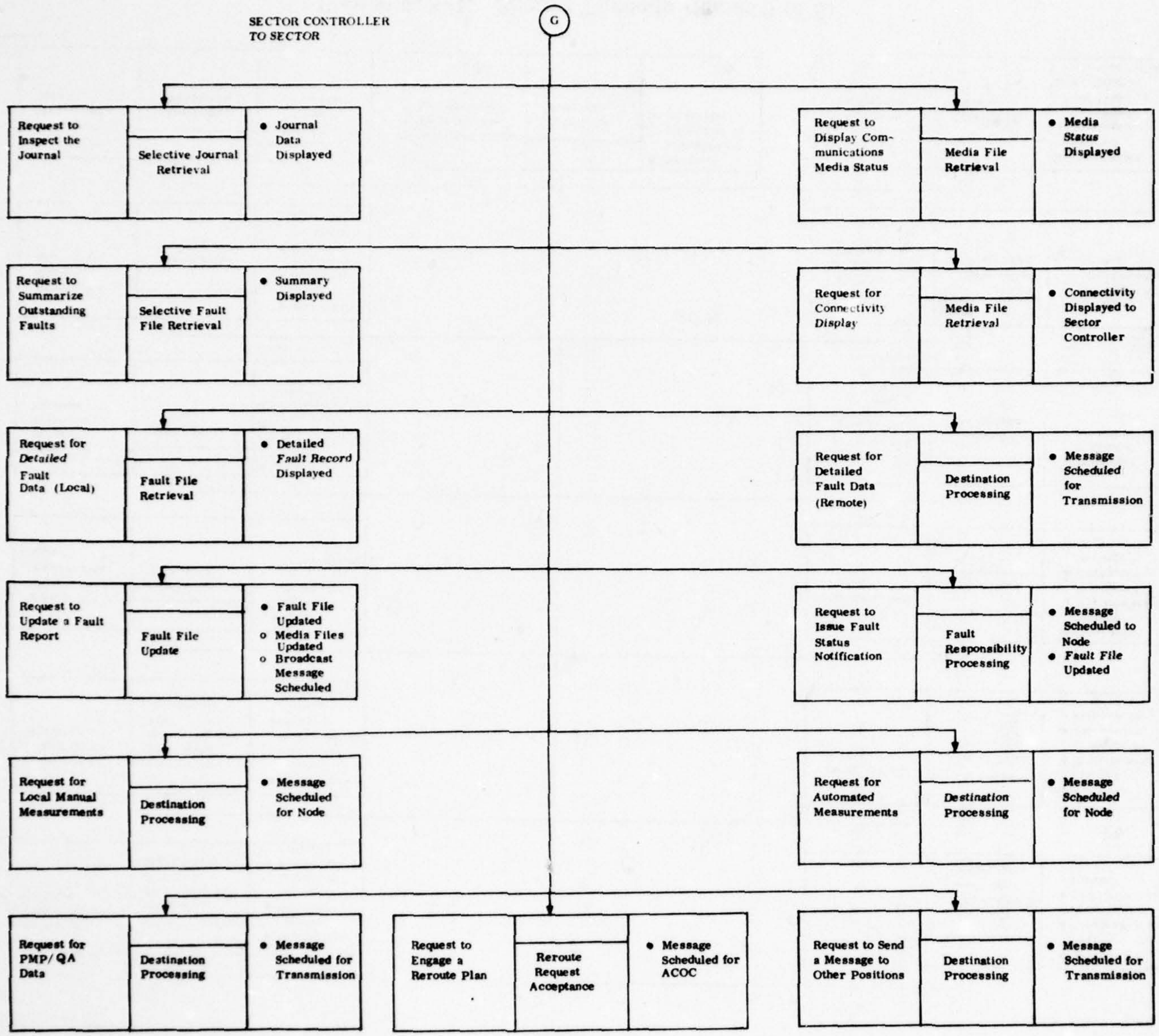


Figure 4.3-1. Sector Threads (Sheet 2 of 5)

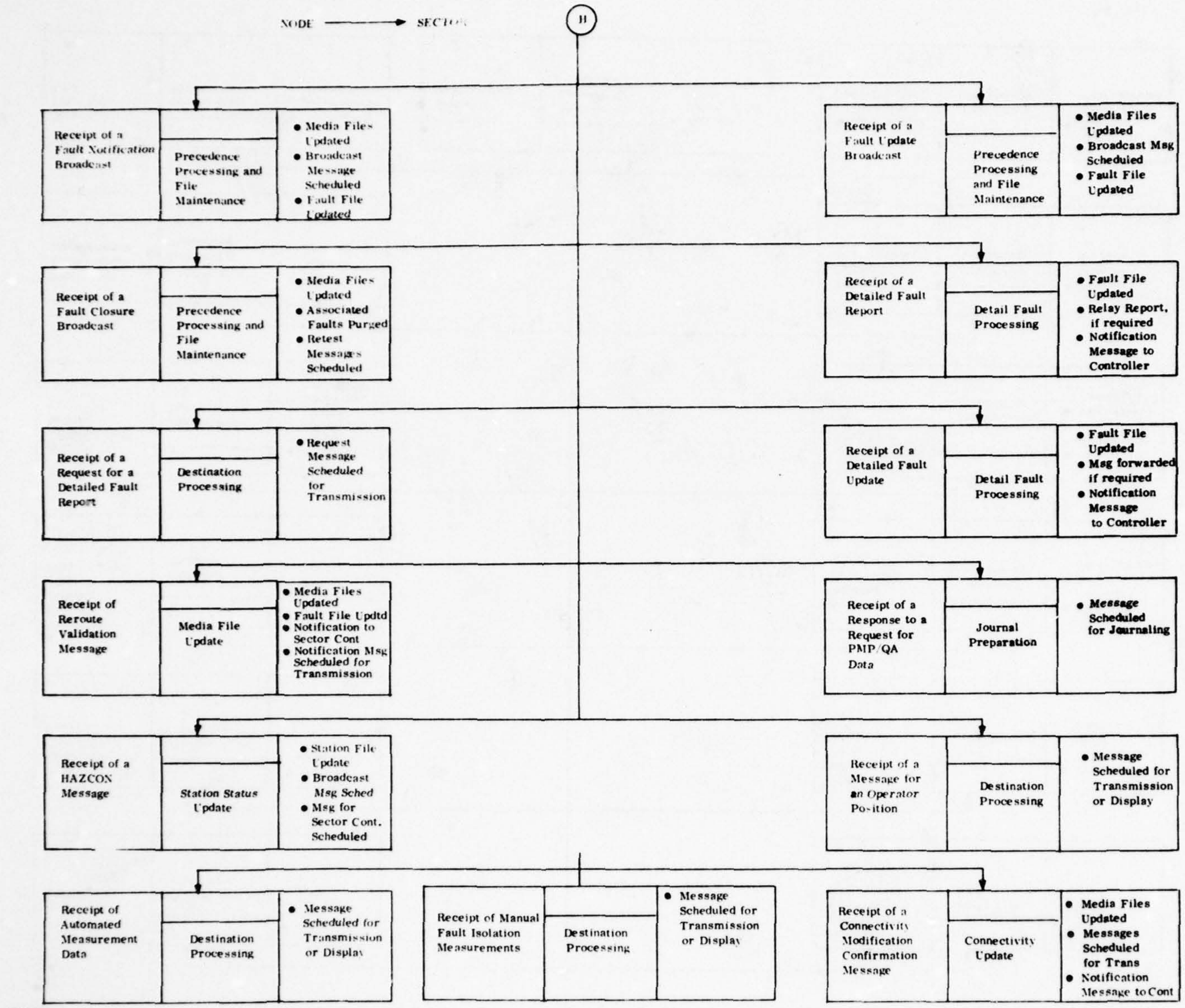


Figure 4.3-1. Sector Threads (Sheet 3 of 5)

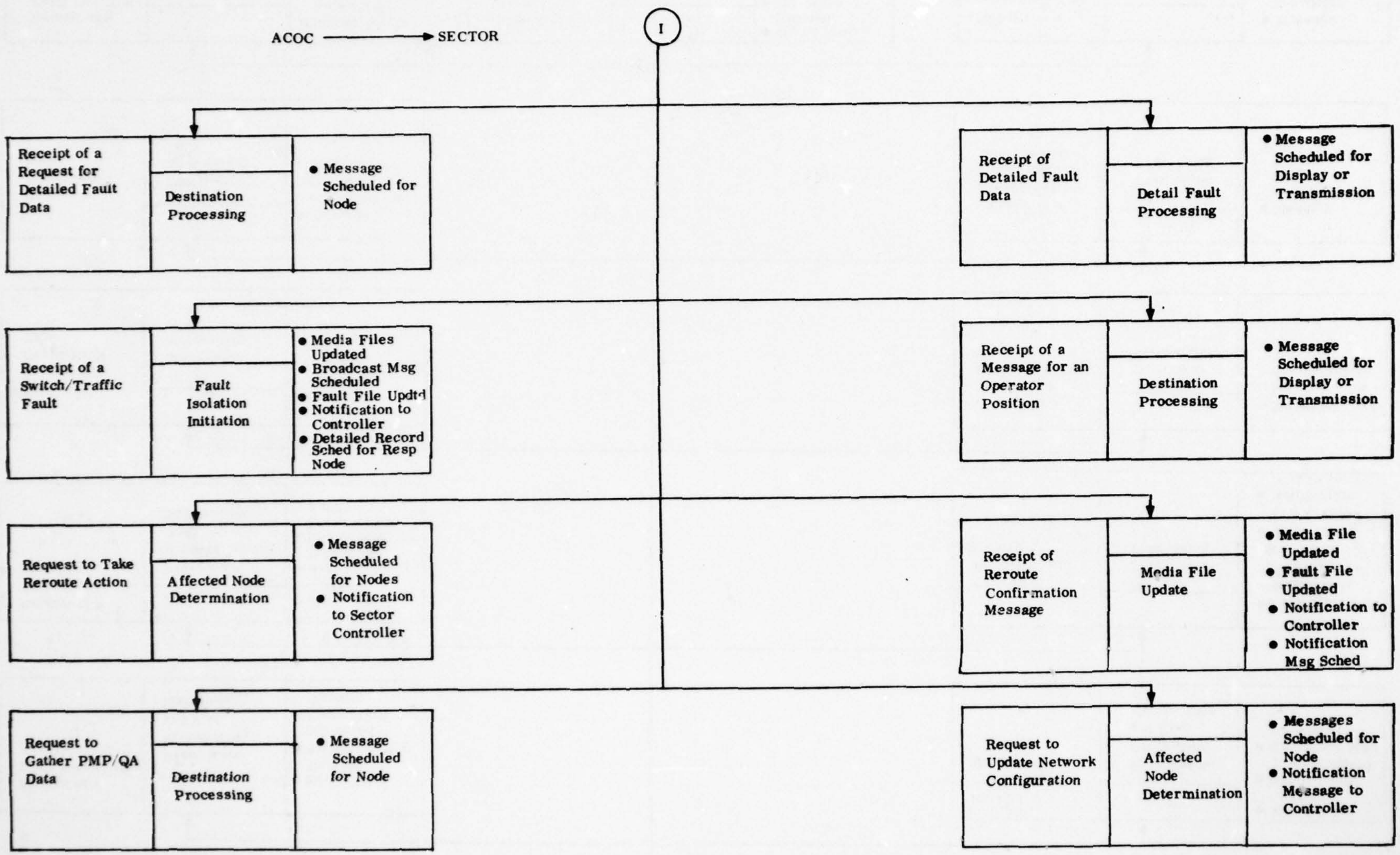


Figure 4.3-1. Sector Threads (Sheet 4 of 5)

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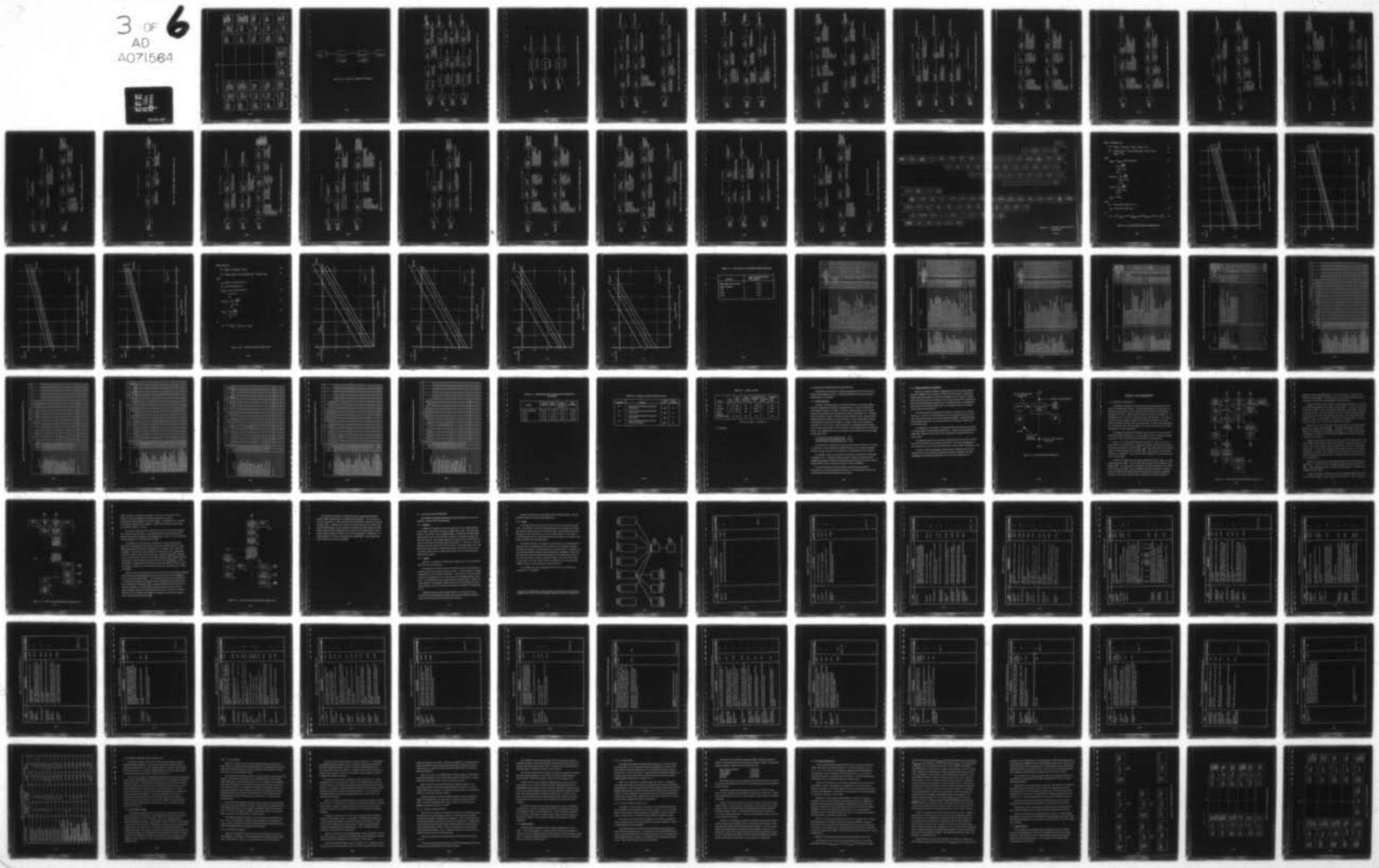

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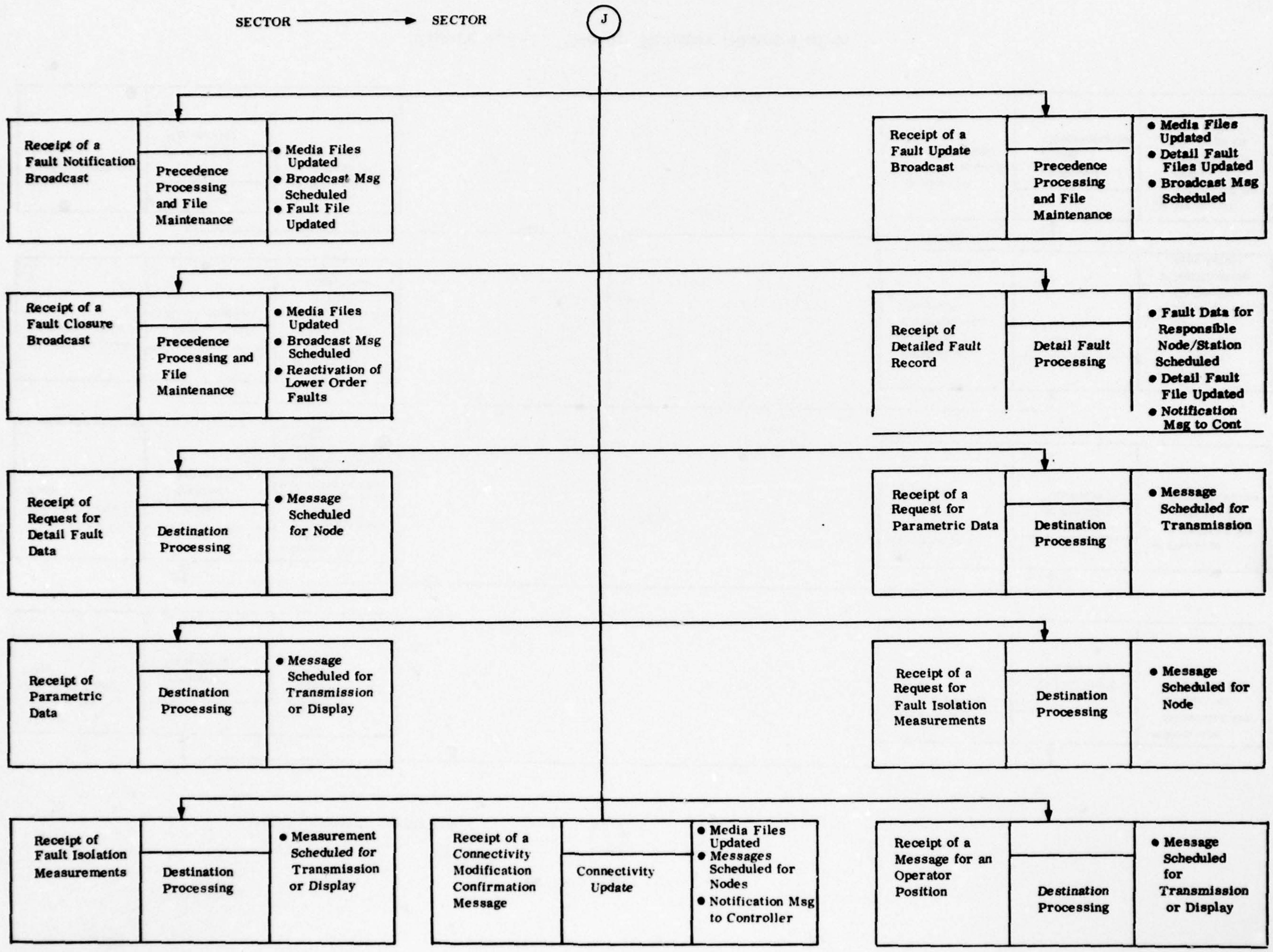


Figure 4.3-1. Sector Threads (Sheet 5 of 5)

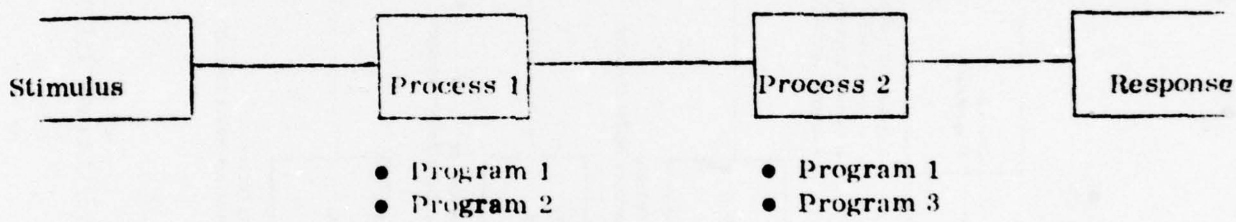


Figure 4.3-2. Format of a THREAD Flow Diagram

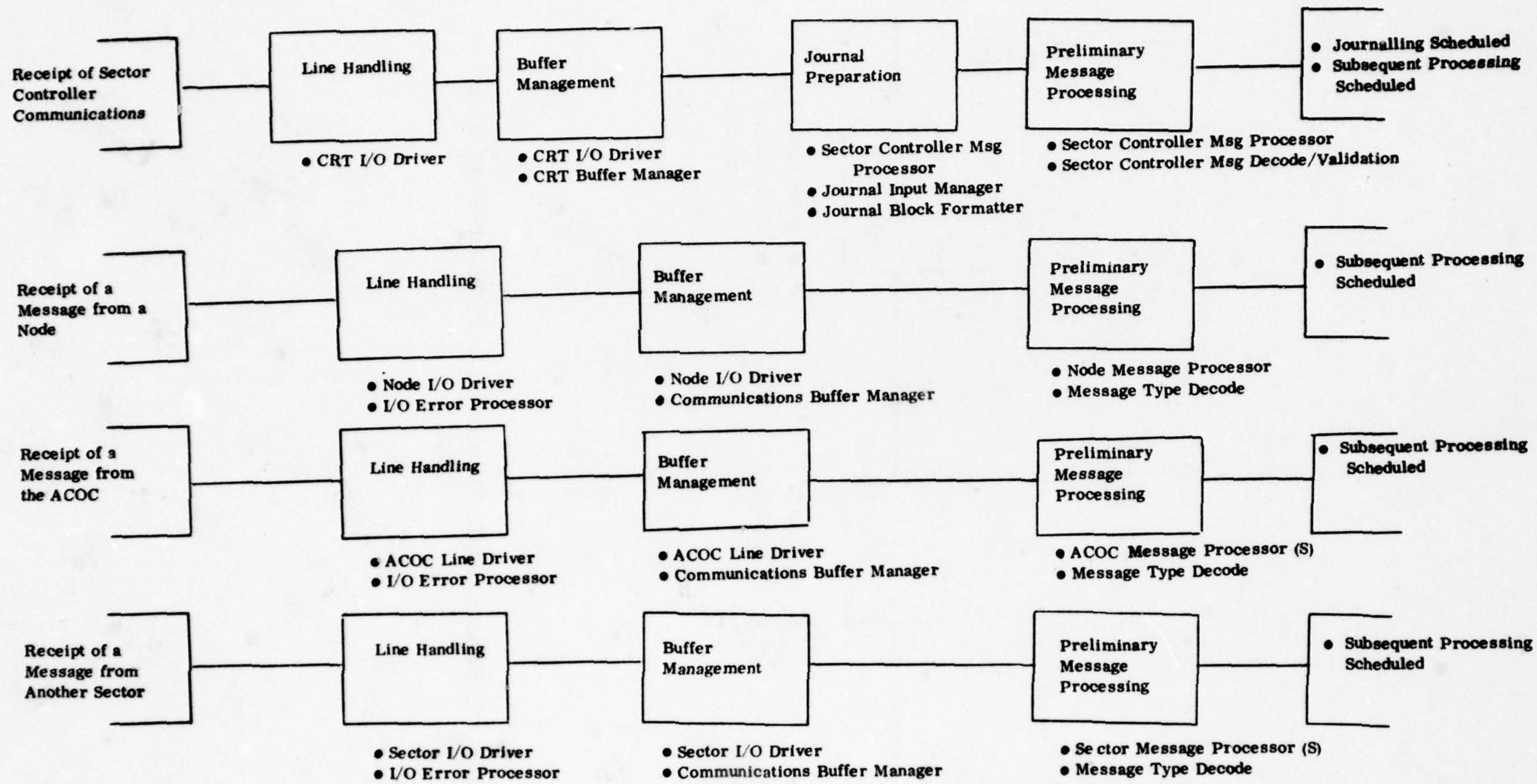


Figure 4.3-3. Supervisory and I/O Level THREADS (Sheet 1 of 2)

SECTOR

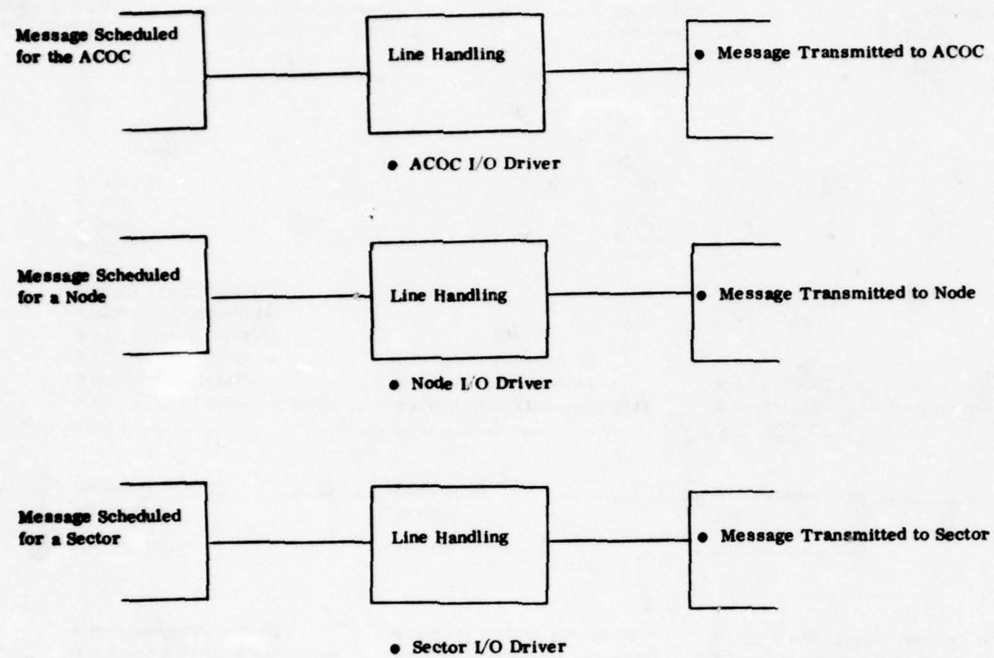


Figure 4.3-3. Supervisory and I/O Level THREADS (Sheet 2 of 2)

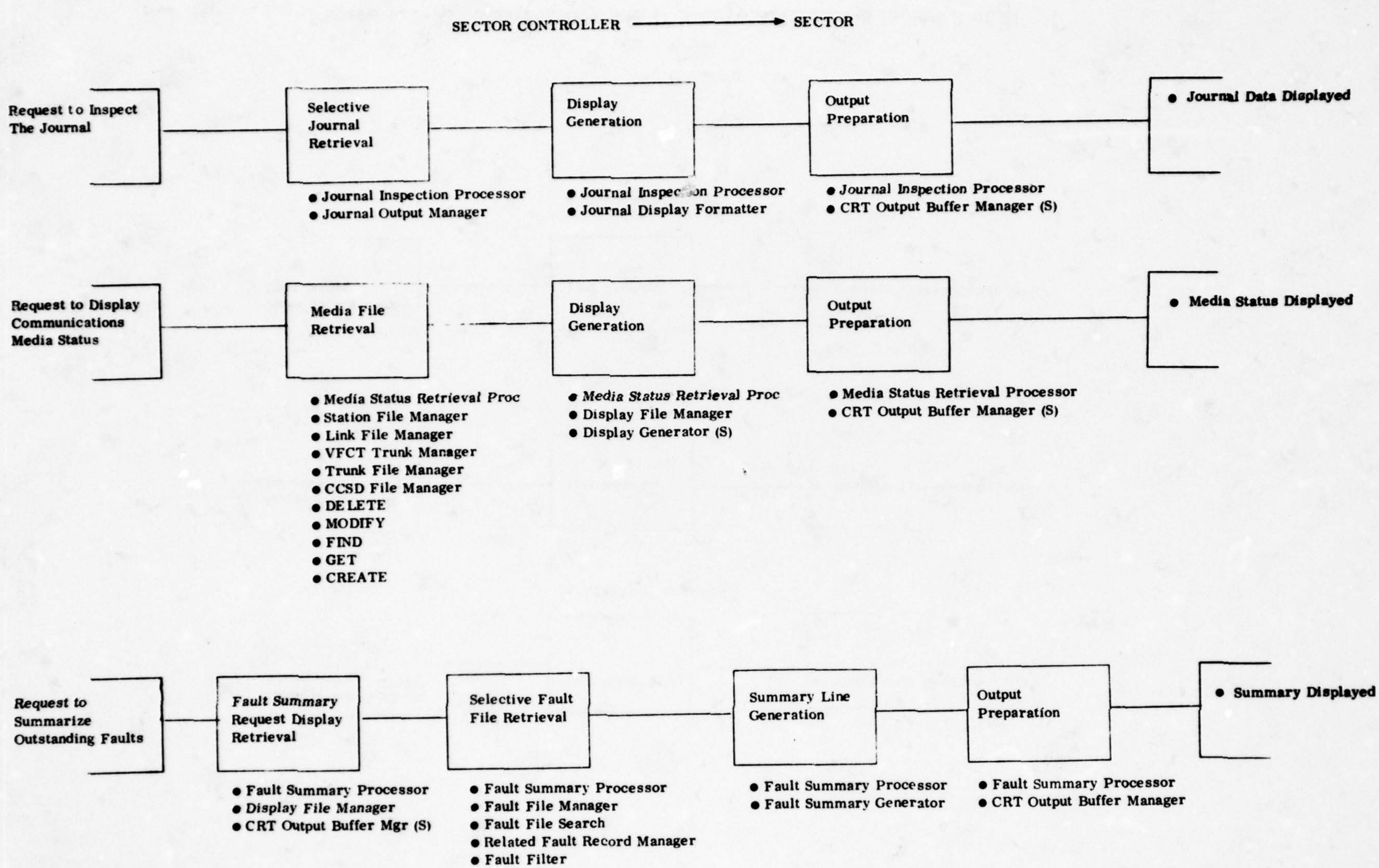


Figure 4.3-4. Sector Controller→Sector THREAD Diagrams (Sheet 1 of 4)

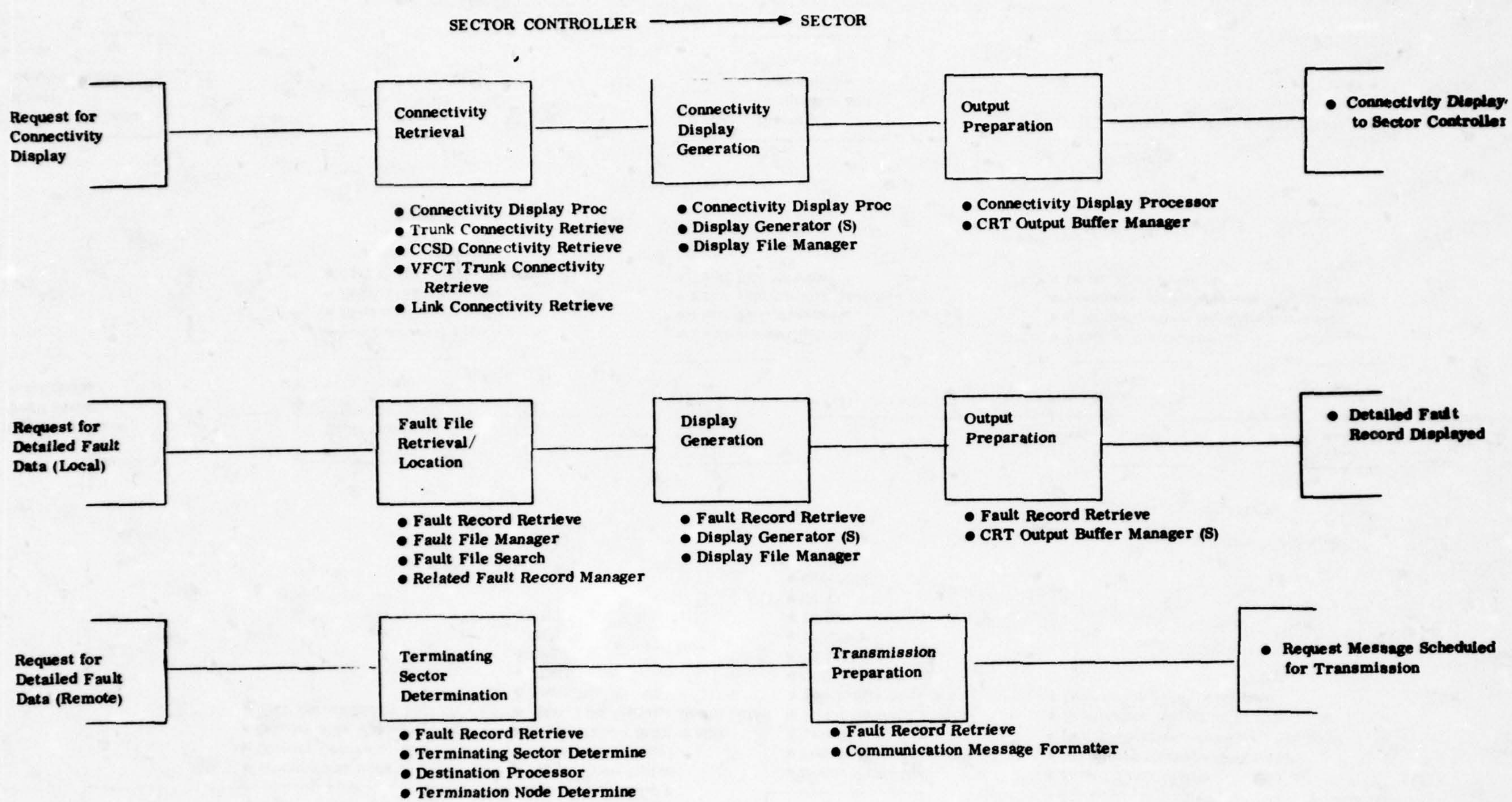


Figure 4.3-4. Sector Controller → Sector THREAD Diagrams (Sheet 2 of 4)

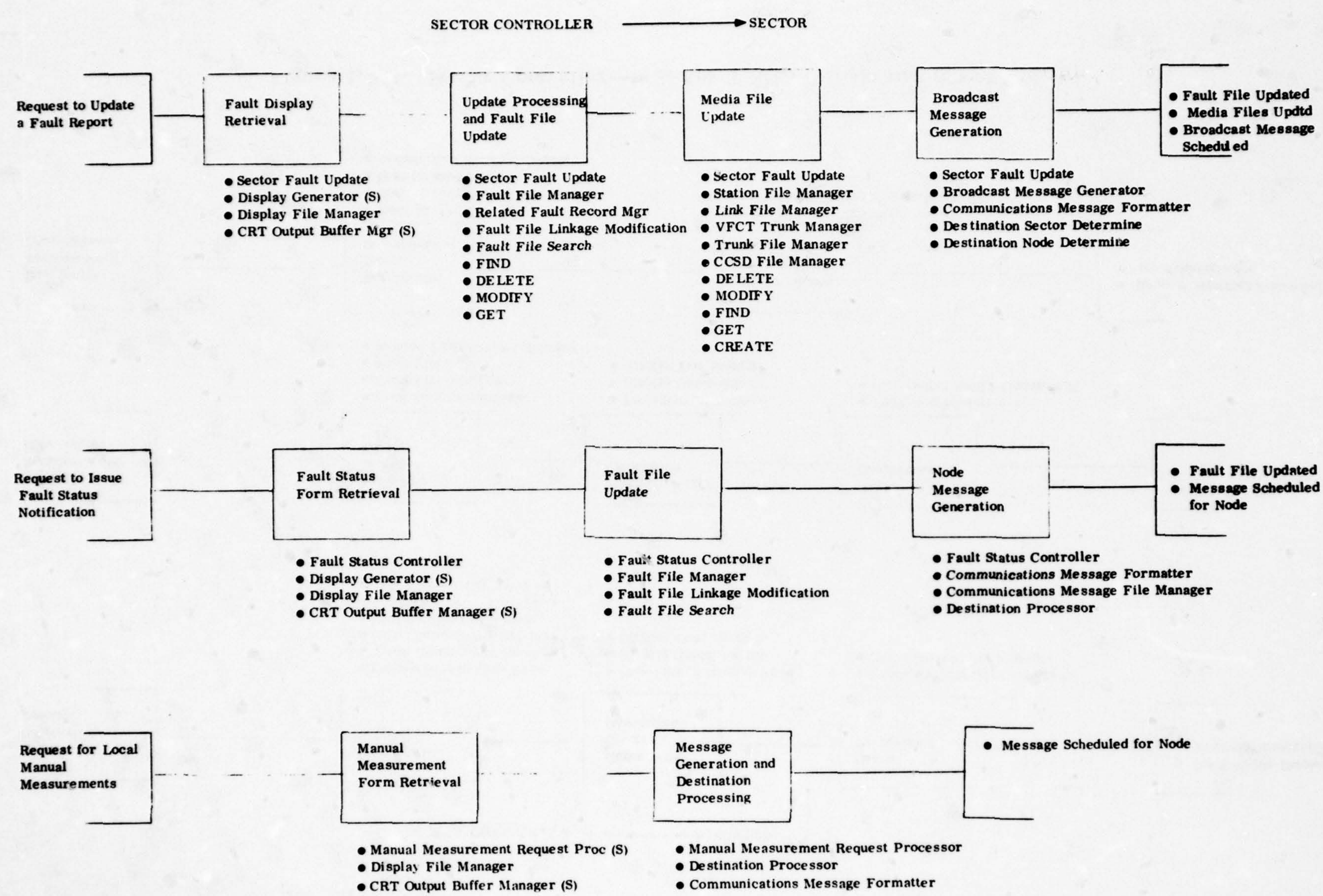


Figure 4.3-4. Sector Controller → Sector THREAD Diagrams (Sheet 3 of 4)

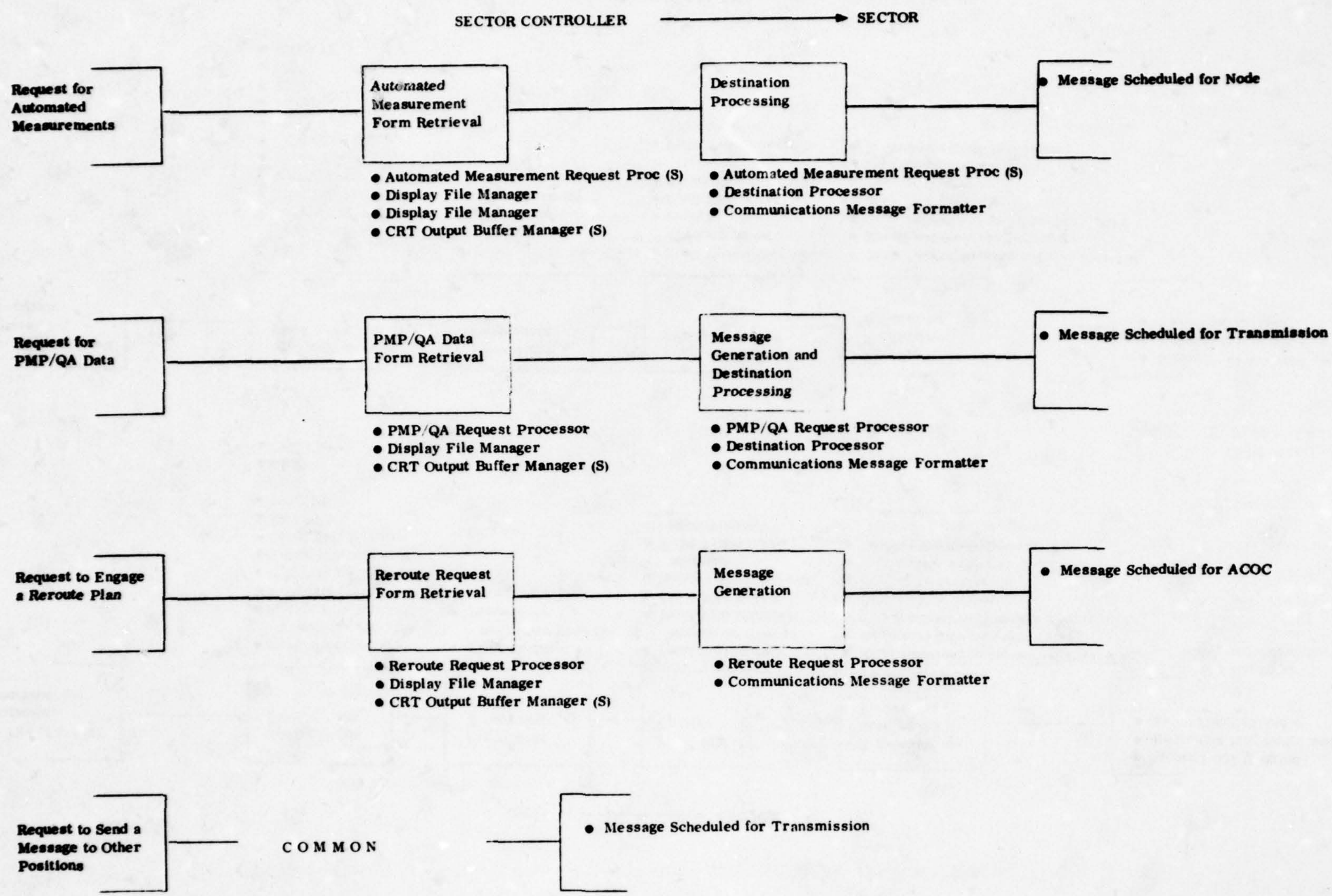


Figure 4.3-4. Sector Controller → Sector THREAD Diagrams (Sheet 4 of 4)

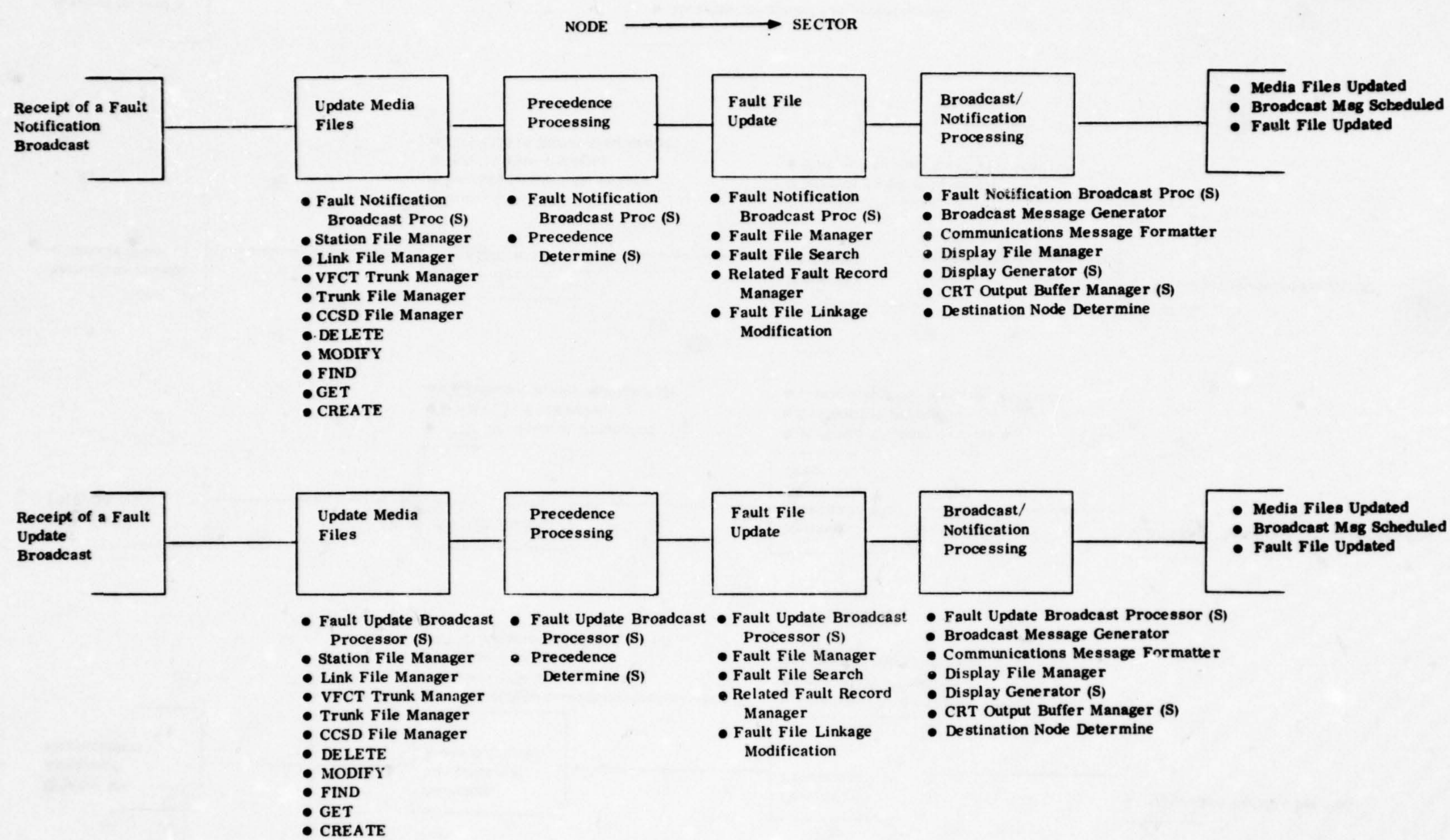


Figure 4.3-5. Node → Sector THREAD Diagrams (Sheet 1 of 6)

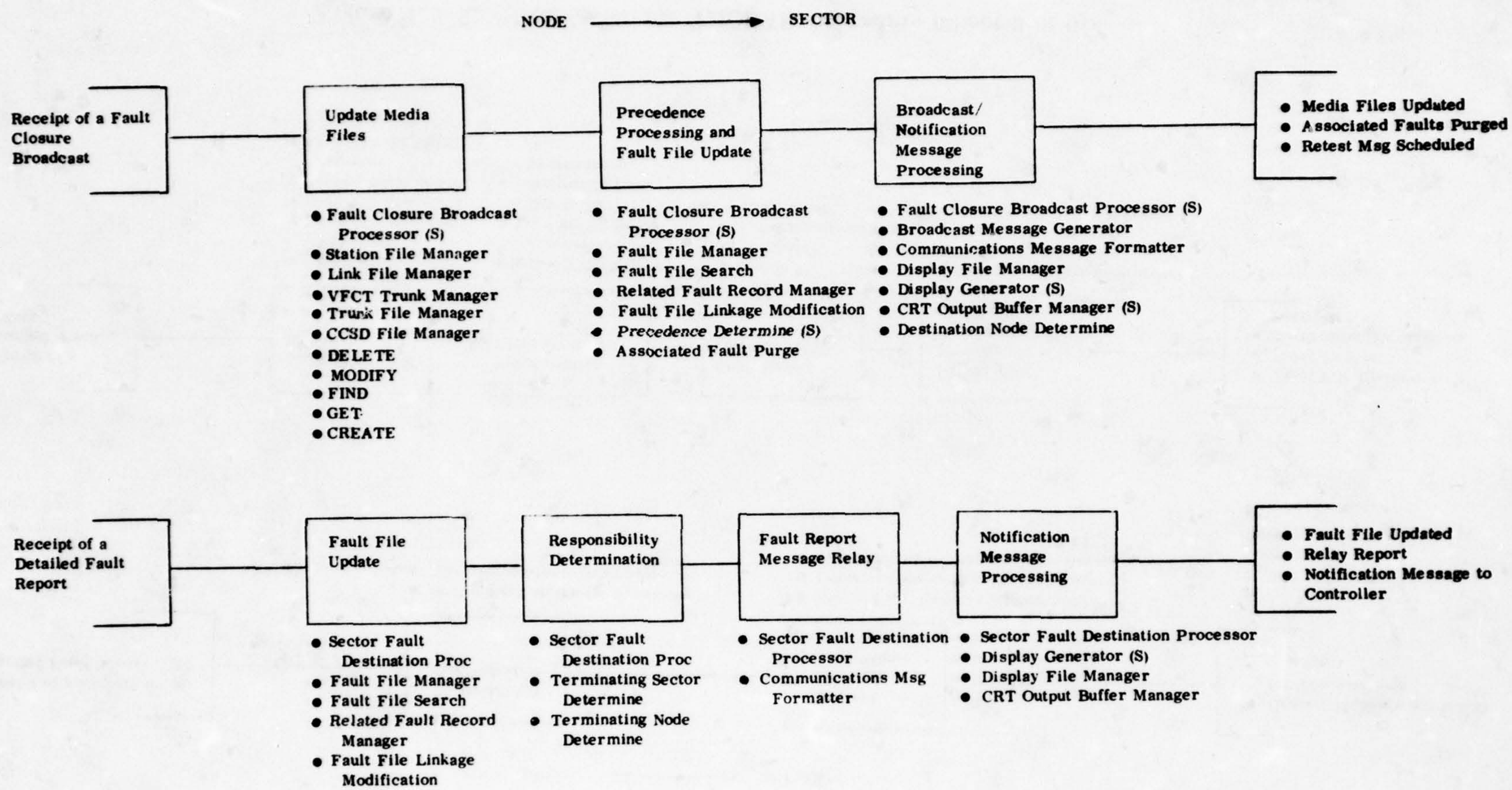


Figure 4.3-5. Node → Sector THREAD Diagrams (Sheet 2 of 6)

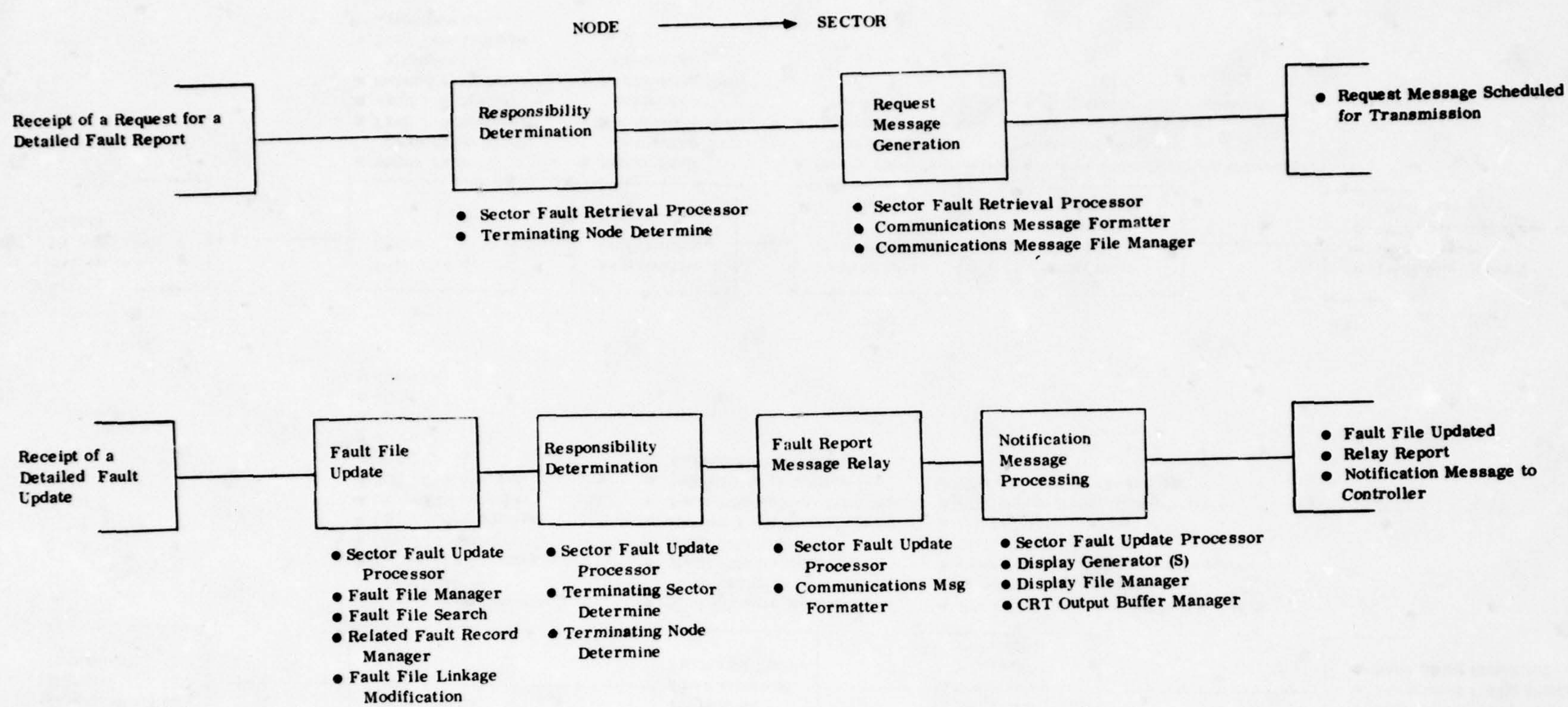


Figure 4.3-5. Node→Sector THREAD Diagrams (Sheet 3 of 6)

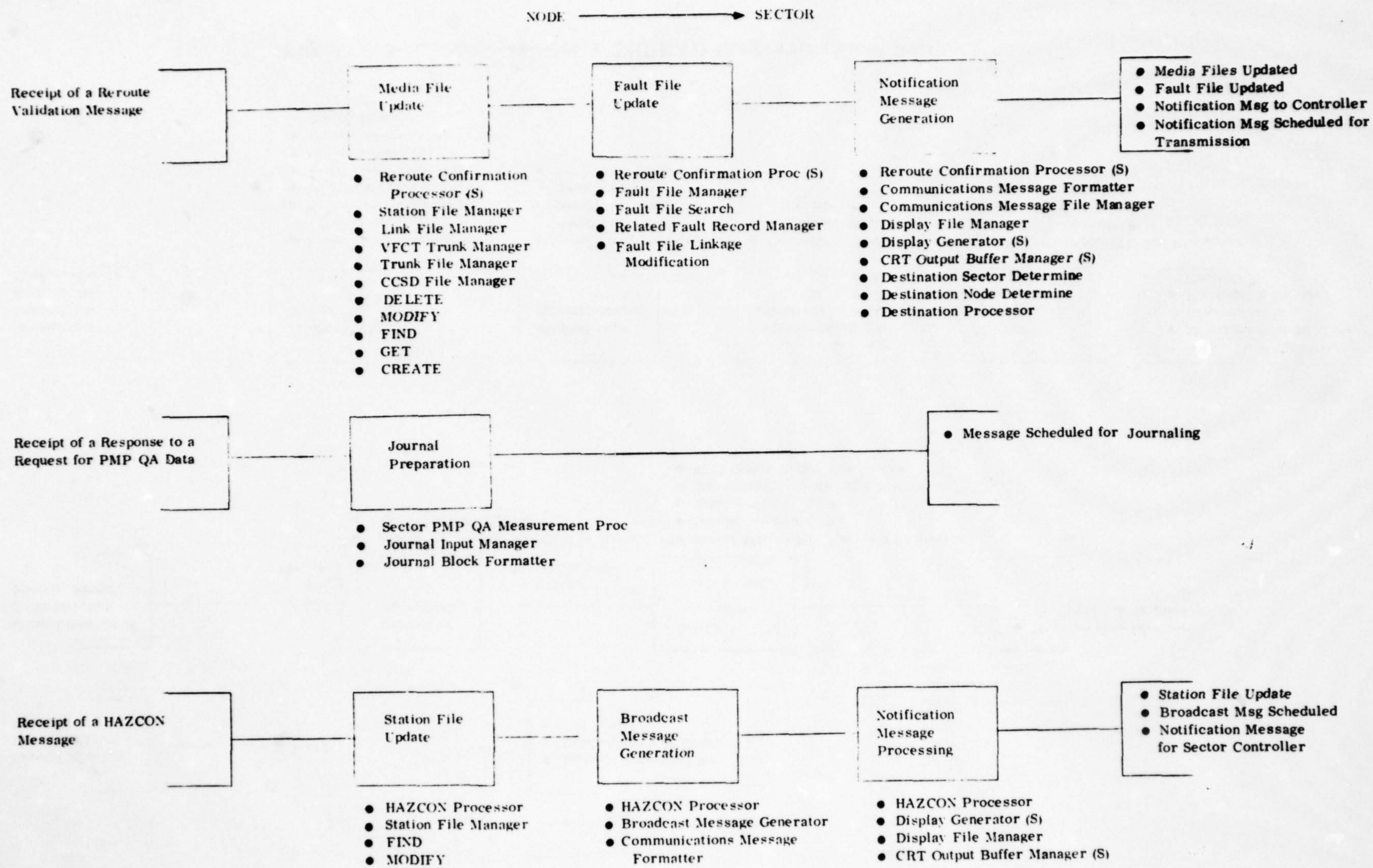


Figure 4.3-5. Node → Sector THREAD Diagrams (Sheet 4 of 6)

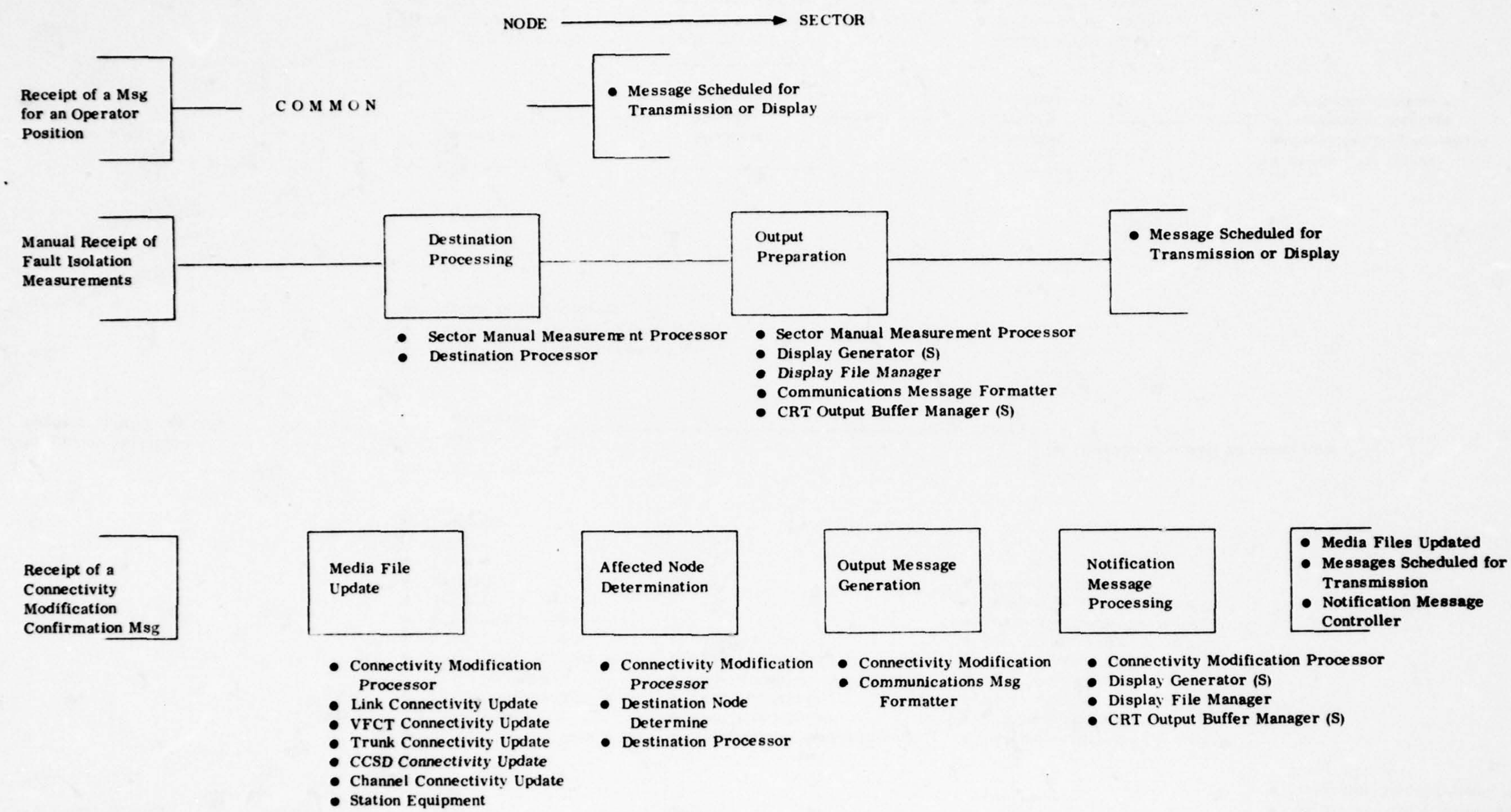


Figure 4.3-5. Node→Sector THREAD Diagrams (Sheet 5 of 6)

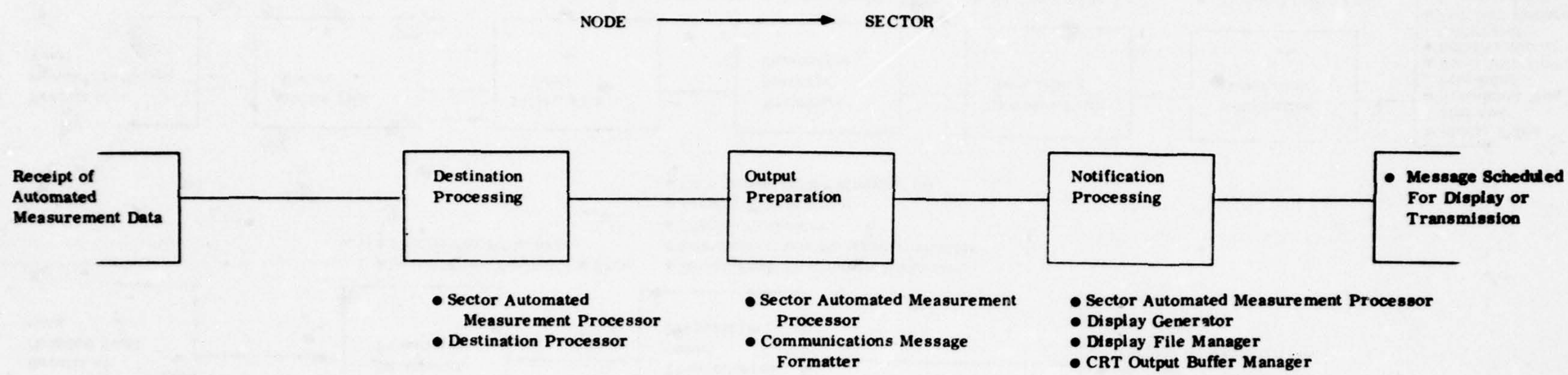


Figure 4.3-5. Node→Sector THREAD Diagrams (Sheet 6 of 6)

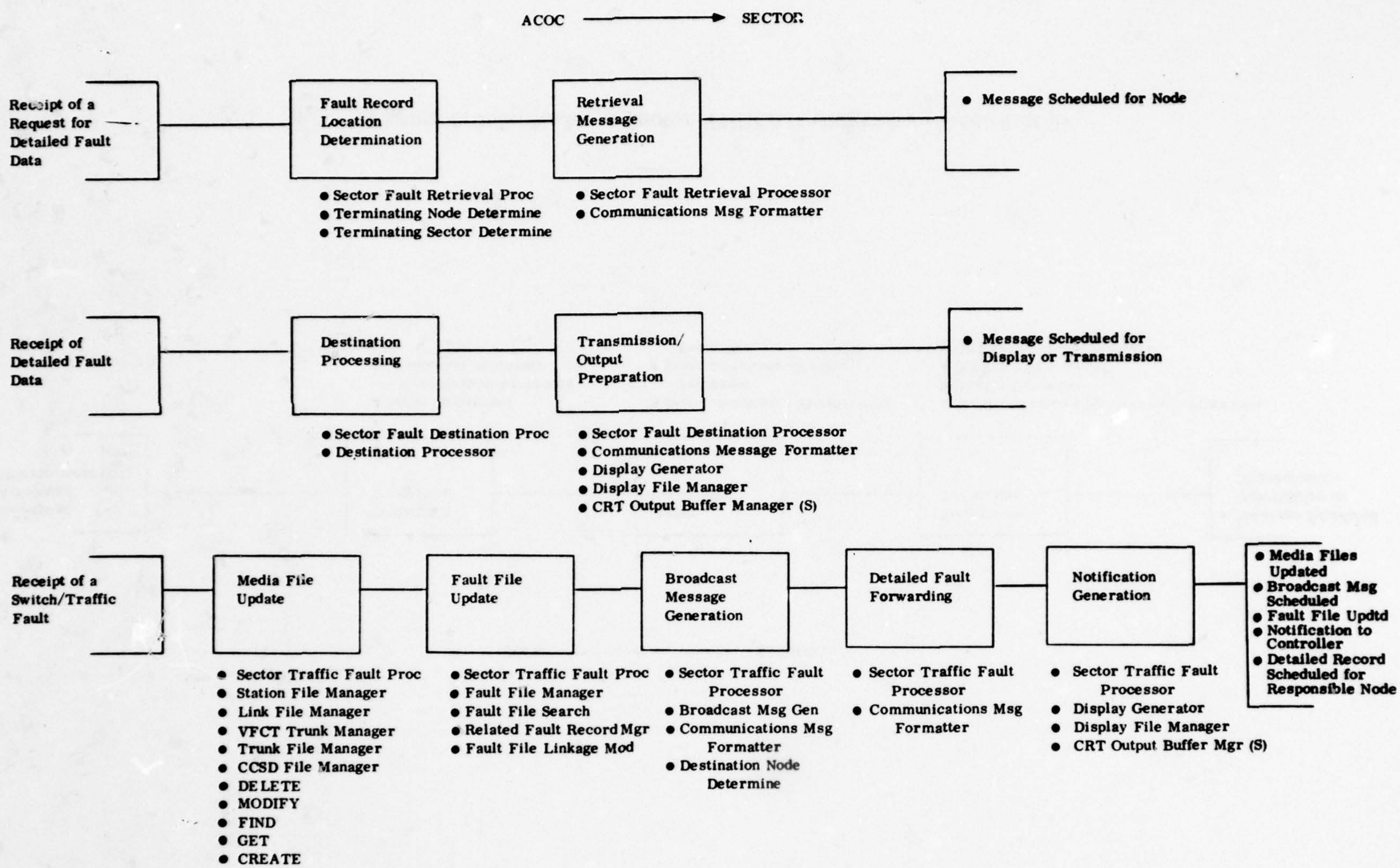


Figure 4.3-6. ACOC → Sector THREAD Diagrams (Sheet 1 of 3)

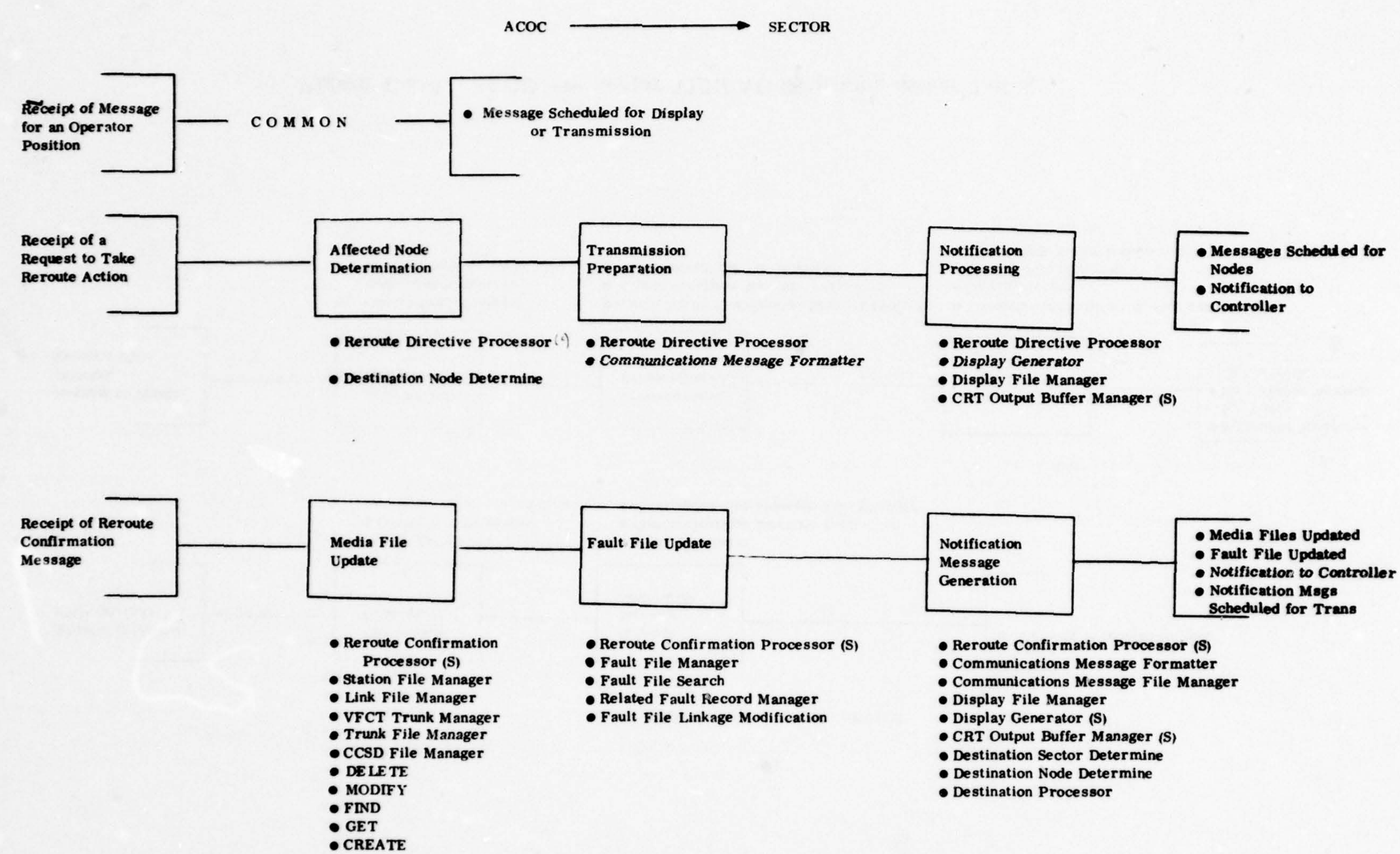


Figure 4.3-6. ACOC → Sector THREAD Diagrams (Sheet 2 of 3)

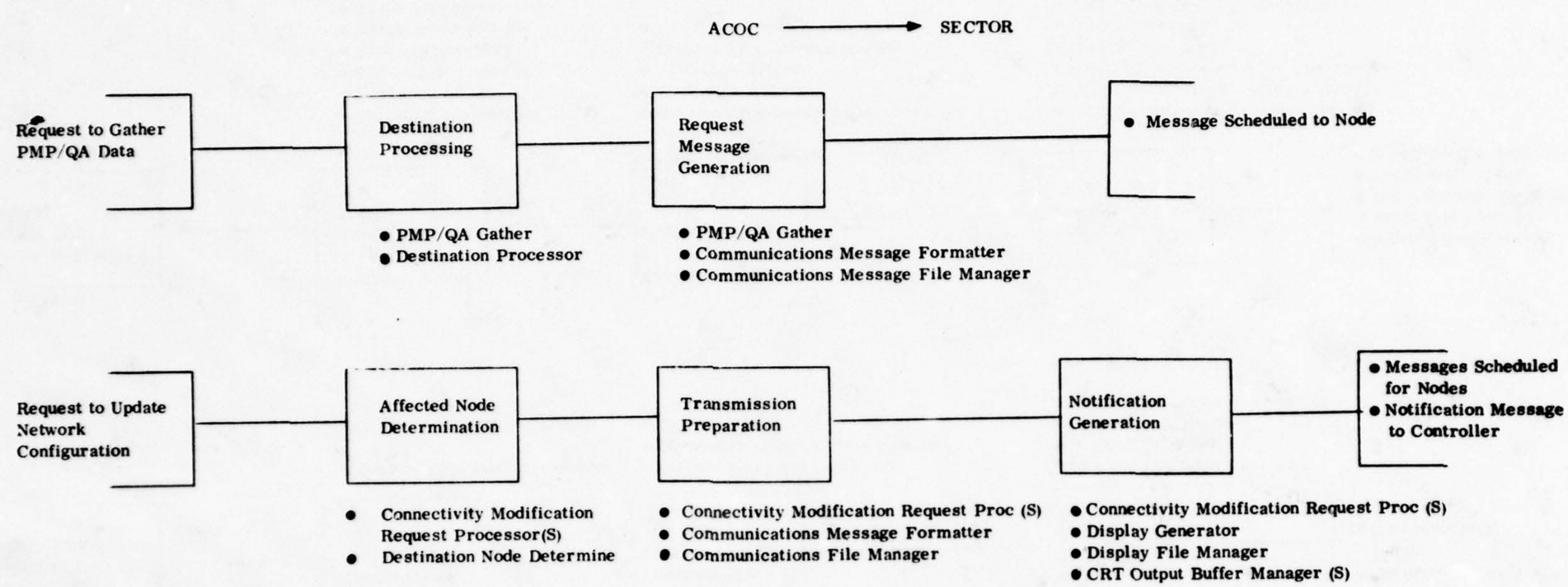


Figure 4.3-6. ACOC → Sector THREAD Diagrams (Sheet 3 of 3)

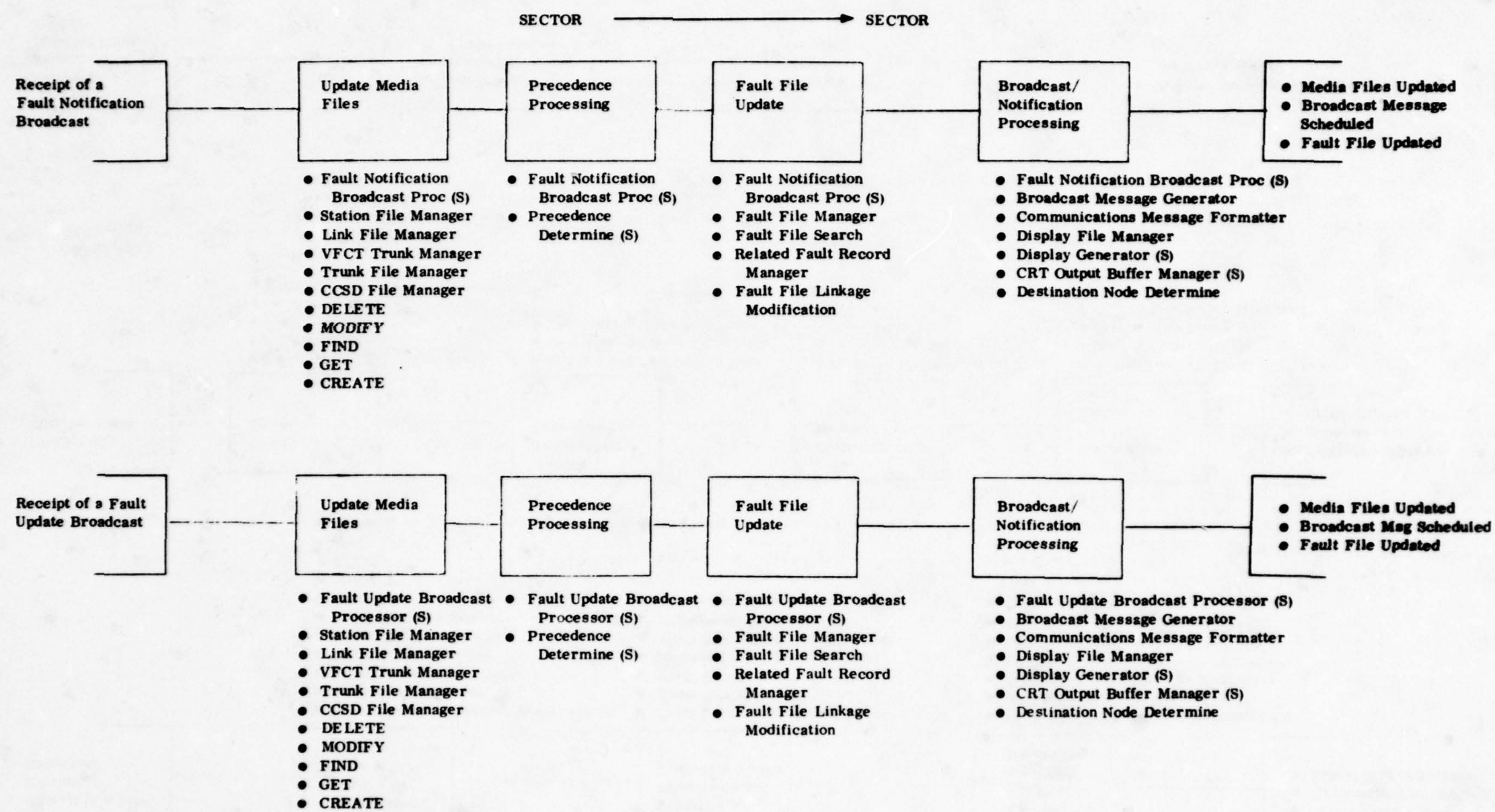


Figure 4.3-7. Sector → Sector THREAD Diagrams (Sheet 1 of 4)

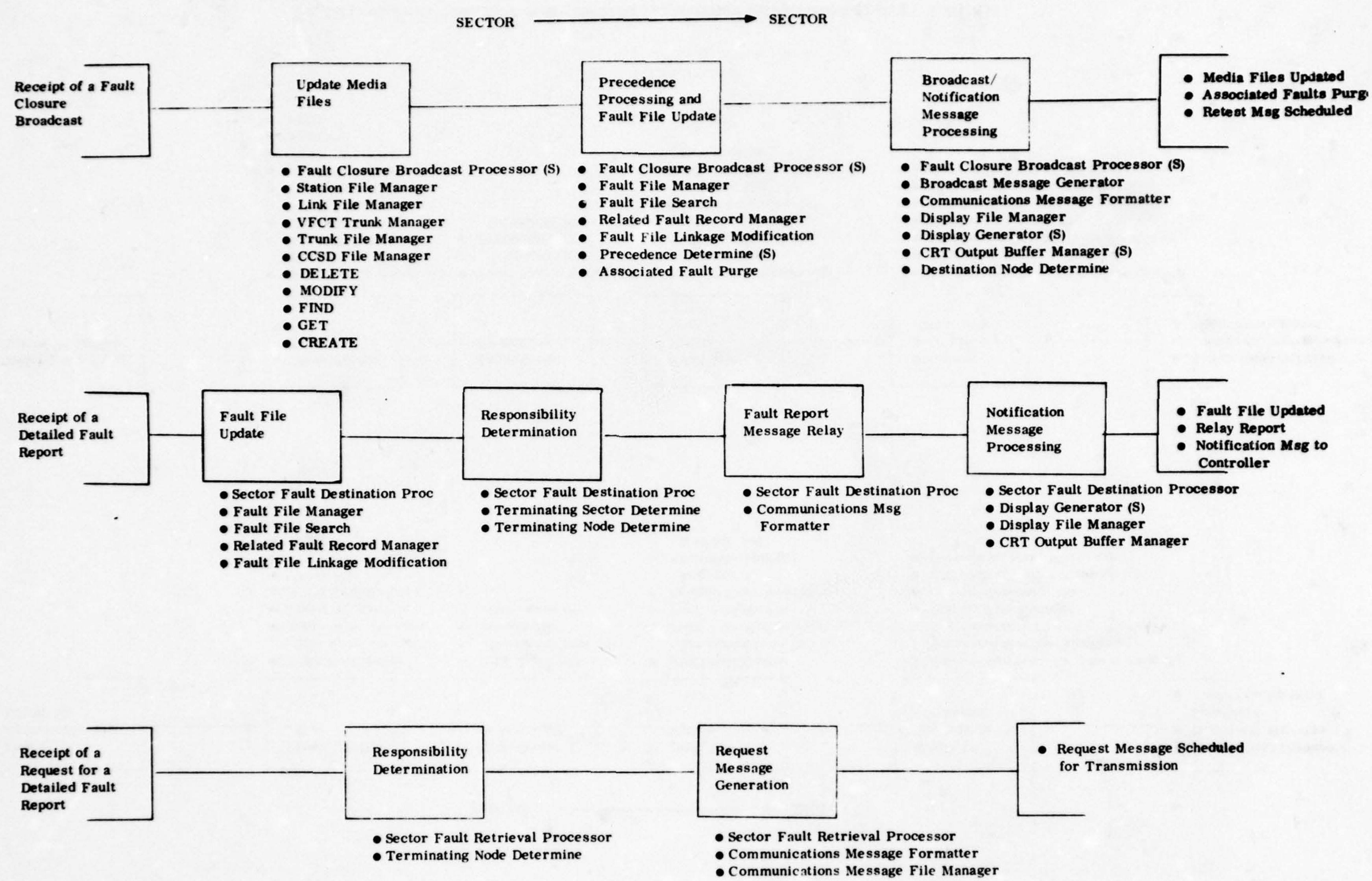


Figure 4.3-7. Sector → Sector THREAD Diagrams (Sheet 2 of 4)

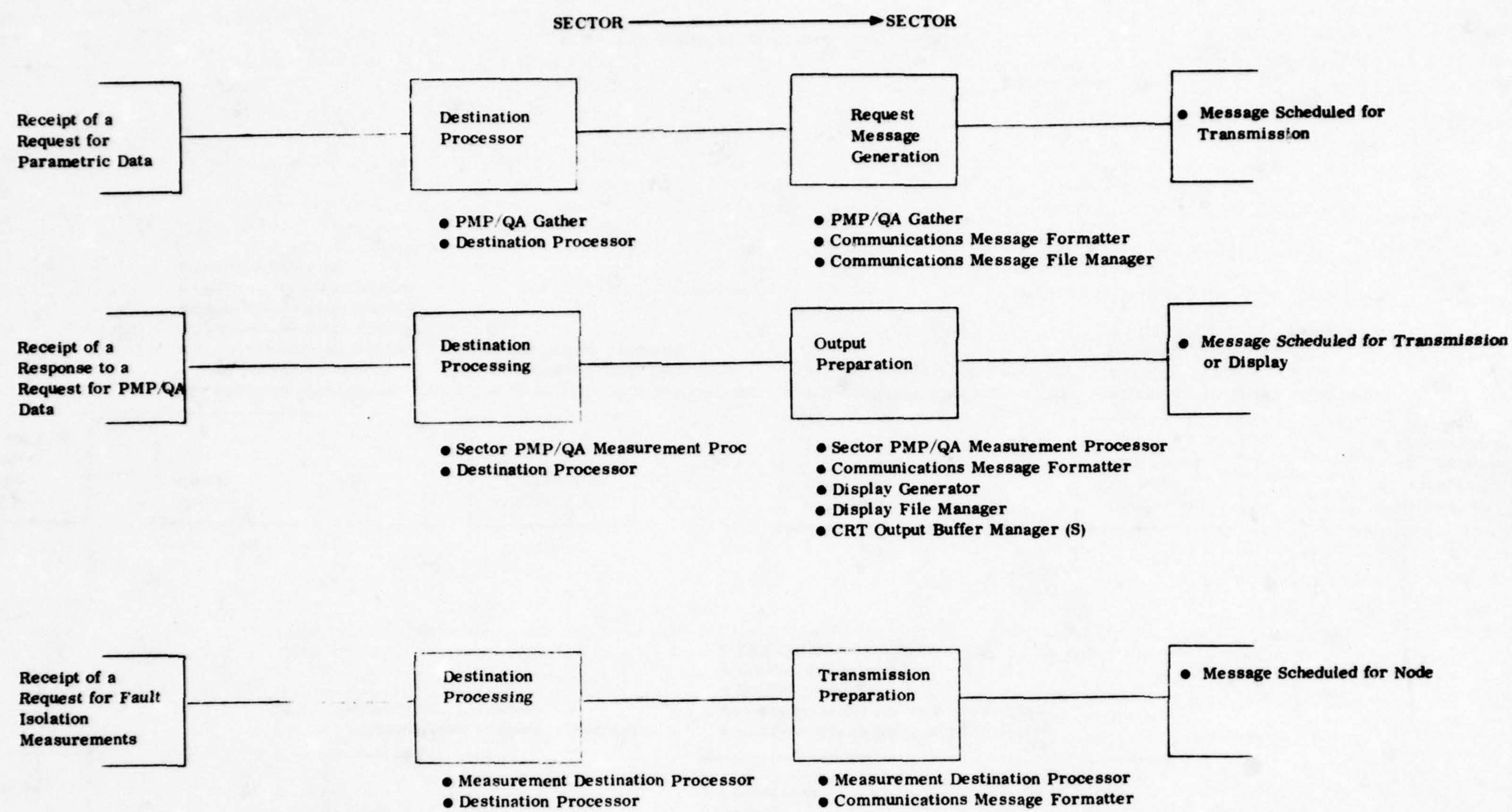


Figure 4.3-7. Sector → Sector THREAD Diagrams (Sheet 3 of 4)

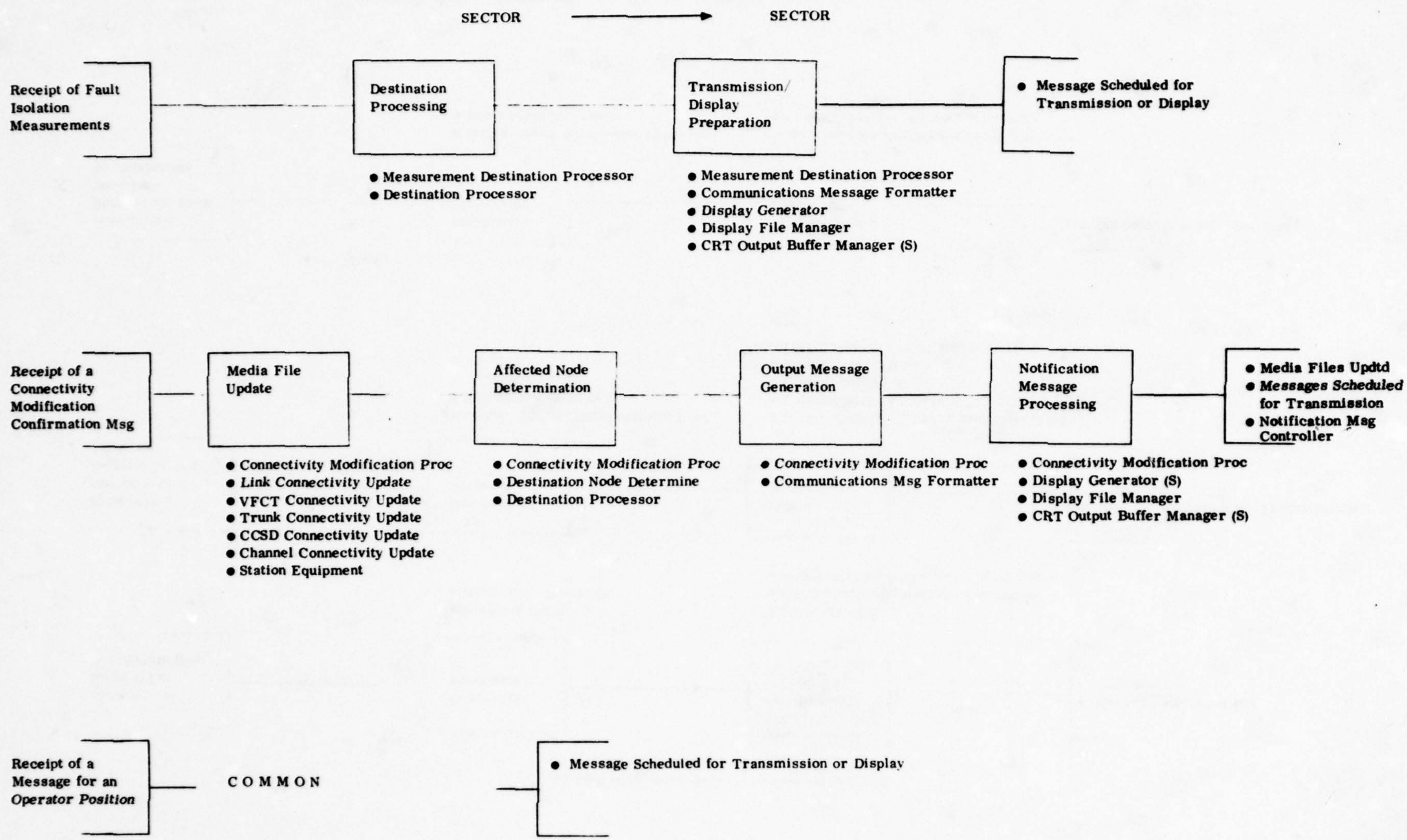
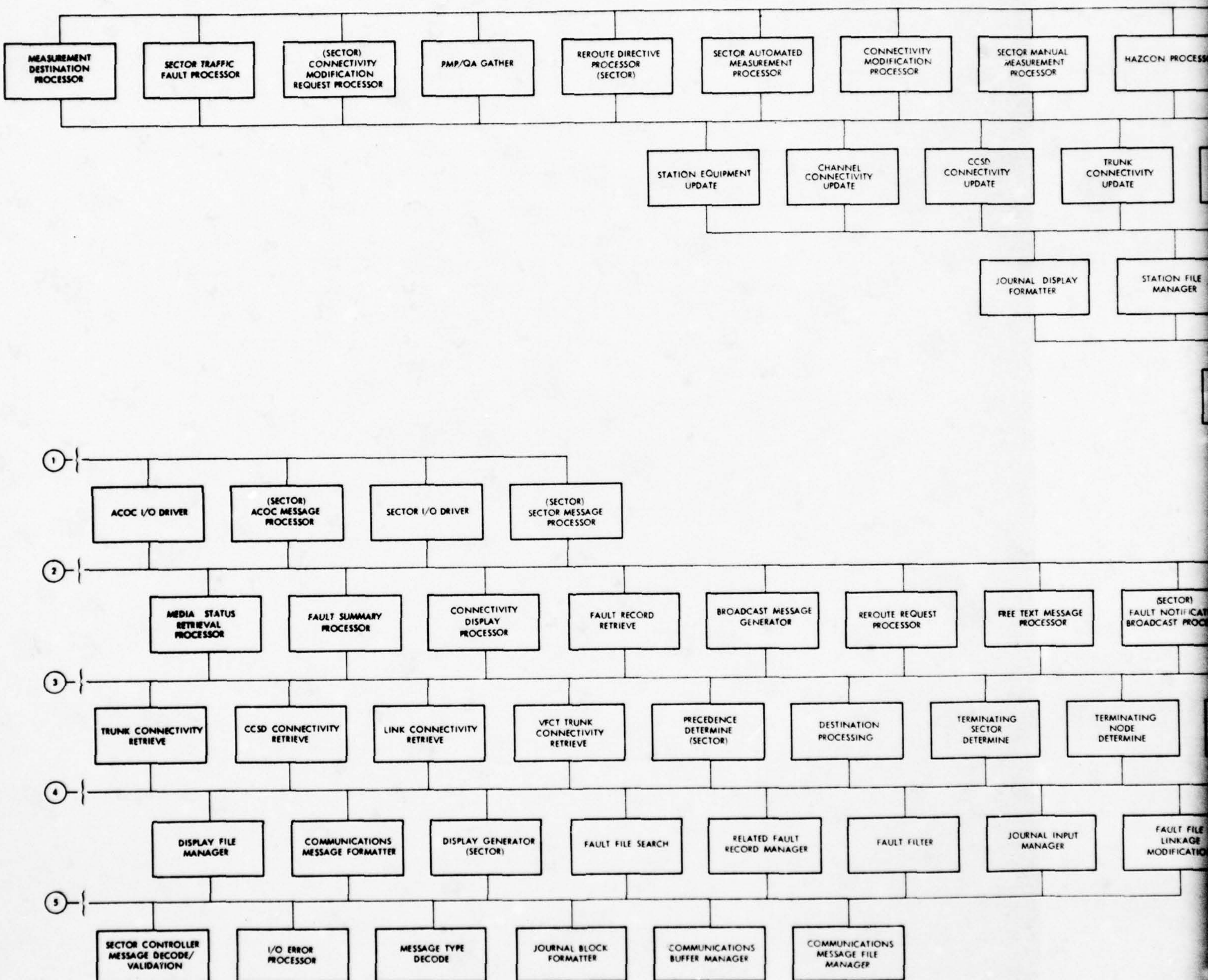


Figure 4.3-7. Sector ⟶ Sector THREAD Diagrams (Sheet 4 of 4)



MEASUREMENT DESTINATION PROCESSOR
SECTOR TRAFFIC FAULT PROCESSOR
(SECTOR) CONNECTIVITY MODIFICATION REQUEST PROCESSOR
PMP/QA GATHER
REROUTE DIRECTIVE PROCESSOR (SECTOR)
SECTOR AUTOMATED MEASUREMENT PROCESSOR
CONNECTIVITY MODIFICATION PROCESSOR
SECTOR MANUAL MEASUREMENT PROCESSOR
STATION EQUIPMENT UPDATE
CHANNEL CONNECTIVITY UPDATE
CCSD CONNECTIVITY UPDATE
TRUNK CONNECTIVITY UPDATE
JOURNAL DISPLAY FORMATTER
STATION FILE MANAGER
1
ACOC I/O DRIVER
(SECTOR) ACOC MESSAGE PROCESSOR
SECTOR I/O DRIVER
(SECTOR) SECTOR MESSAGE PROCESSOR
2
MEDIA STATUS RETRIEVAL PROCESSOR
FAULT SUMMARY PROCESSOR
CONNECTIVITY DISPLAY PROCESSOR
FAULT RECORD RETRIEVE
BROADCAST MESSAGE GENERATOR
REROUTE REQUEST PROCESSOR
FREE TEXT MESSAGE PROCESSOR
3
TRUNK CONNECTIVITY RETRIEVE
CCSD CONNECTIVITY RETRIEVE
LINK CONNECTIVITY RETRIEVE
VFCT TRUNK CONNECTIVITY RETRIEVE
PRECEDENCE DETERMINE (SECTOR)
DESTINATION PROCESSING
TERMINATING SECTOR DETERMINE
TERMINATING NODE DETERMINE
4
DISPLAY FILE MANAGER
COMMUNICATIONS MESSAGE FORMATTER
DISPLAY GENERATOR (SECTOR)
FAULT FILE SEARCH
RELATED FAULT RECORD MANAGER
FAULT FILTER
JOURNAL INPUT MANAGER
5
SECTOR CONTROLLER MESSAGE DECODE/ VALIDATION
I/O ERROR PROCESSOR
MESSAGE TYPE DECODE
JOURNAL BLOCK FORMATTER
COMMUNICATIONS BUFFER MANAGER
COMMUNICATIONS MESSAGE FILE MANAGER

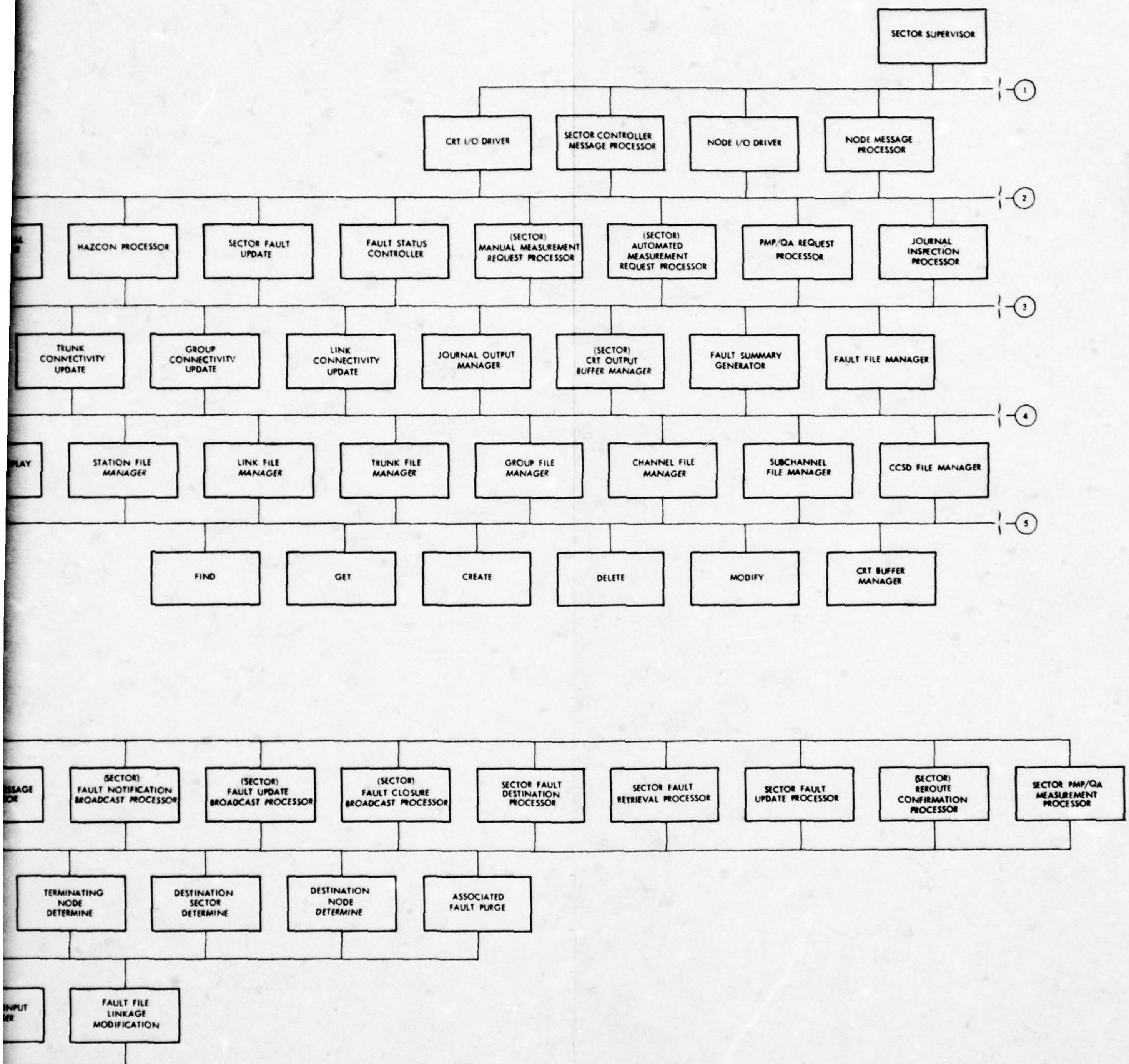


Figure 4.3-8. Computer Program Hierarchy for the Sector

Sector Processing Load:

$$P_S = P_{NODE} + P_{SECTOR} + P_{ACOC} + P_{DISK} + P_{I/O} \quad (1)$$

$$P_S = L_{NODE}\, R_{NODE} + L_{SECTOR}\, R_{SECTOR} + L_{ACOC}\, R_{ACOC} + P_{DISK} + P_{I/O} \quad (2)$$

where

$$L_{NODE} = (I_{NODE})\ (\text{Time conversion}) \quad (3)$$

$$= (I_{S3})\ (\frac{MIN}{SEC})$$

$$= (2768)\ (1/60)$$

$$= 46.13$$

$$L_{SECTOR} = (I_{N1})\ (\frac{MIN}{SEC}) \quad (4)$$

$$= (2288)\ (1/60)$$

$$= 38.13$$

$$L_{ACOC} = (I_{N2})\ (\frac{MIN}{SEC}) \quad (5)$$

$$= (2288)\ (1/60)$$

$$= 38.13$$

$$P_{DISK} = 256\ D_S \quad (6)$$

where

D_S = Disk Load (see Figure 4.3-11)

$P_{I/O}$ = 18,900 (see Table 4.3-7) (7)

so

$$P_S = 46.13\ R_{NODE} + 38.13\ R_{SECTOR} + 38.13\ R_{ACOC} + 256\ D_S + 18{,}900 \quad (8)$$

Figure 4.3-9. Derivation of the Sector Processing Load

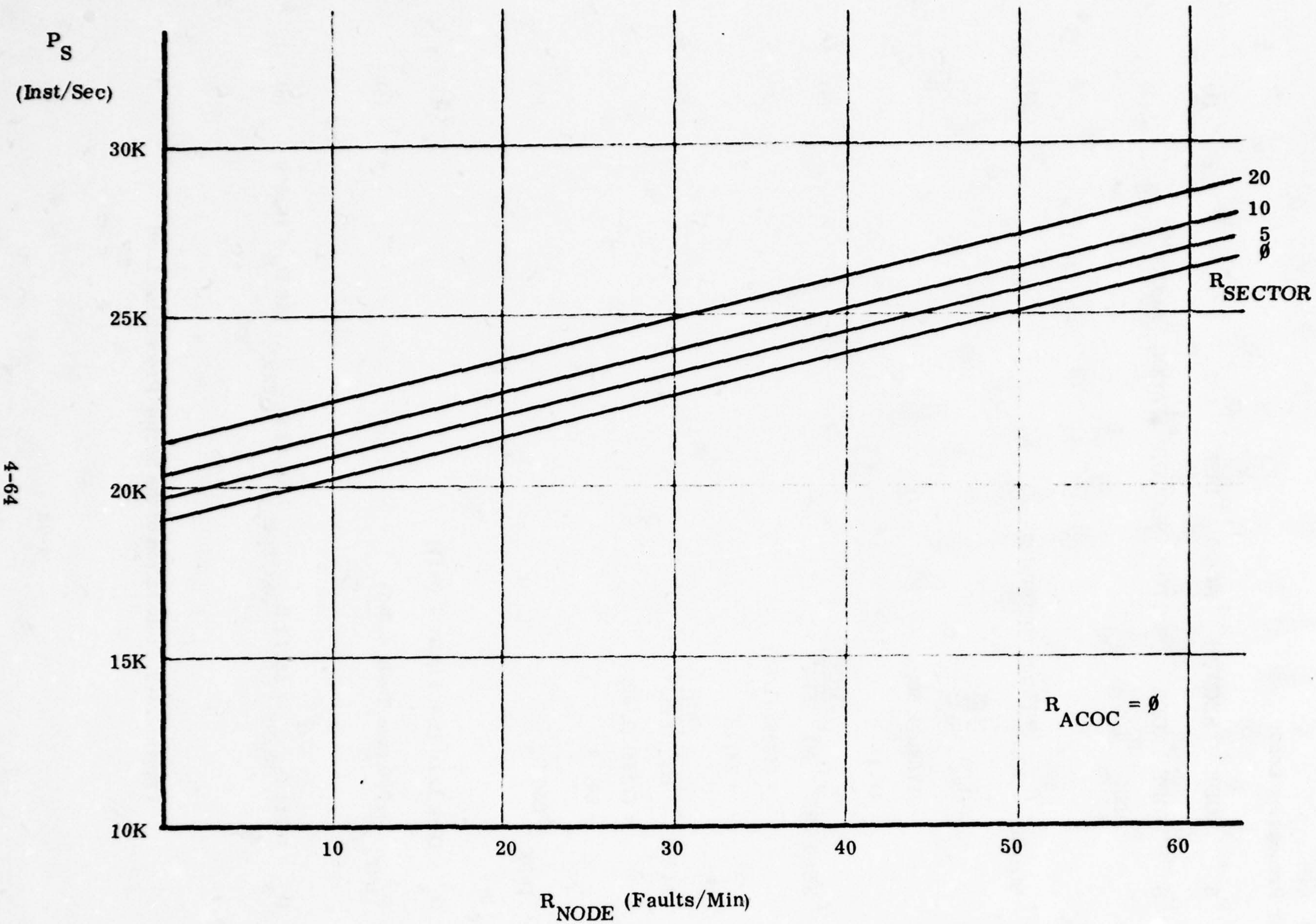


Figure 4.3-10 (Sheet 1). Sector Processing Load ($R_{ACOC} = 0$)

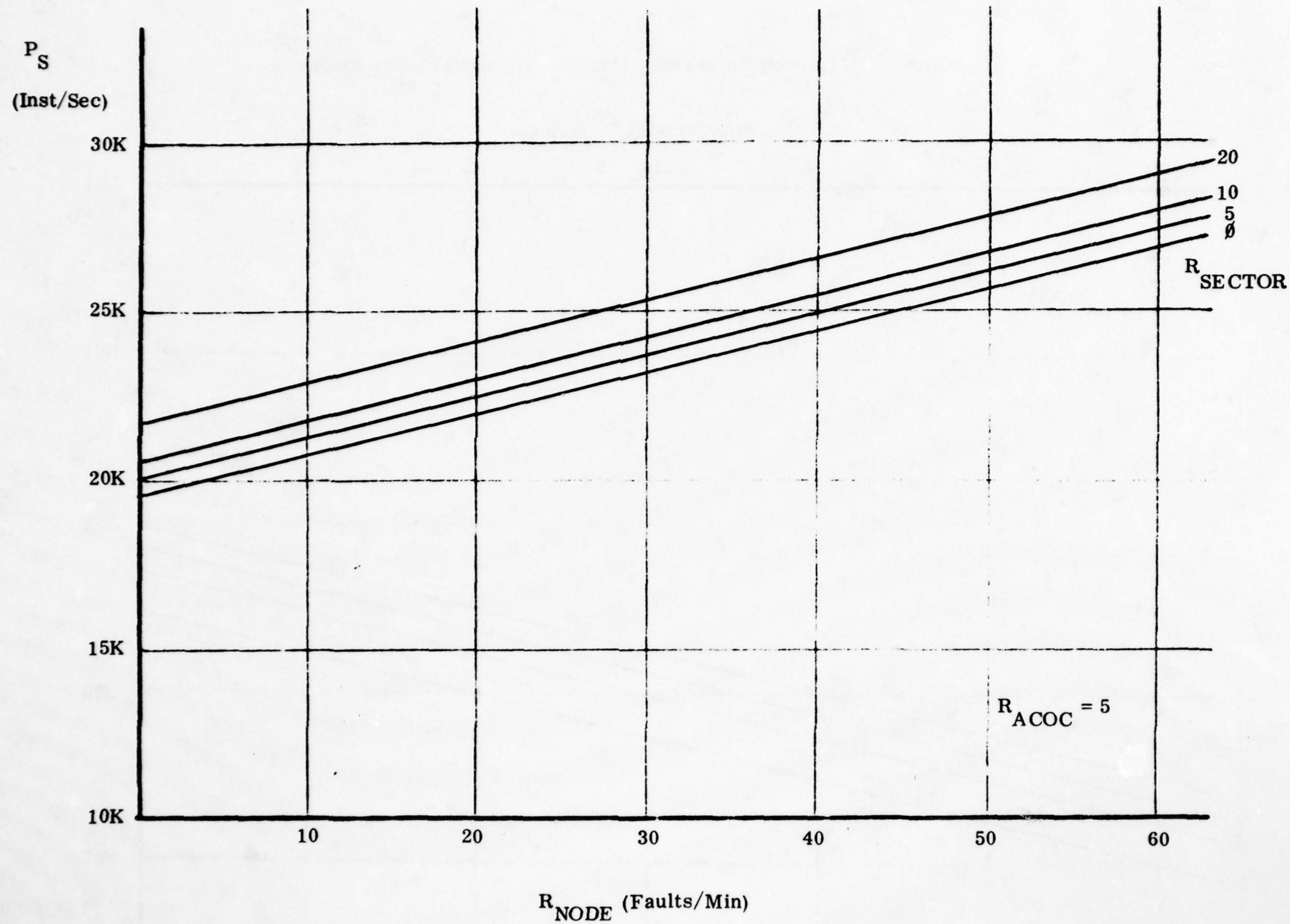


Figure 4.3-10 (Sheet 2). Sector Processing Load (R_{ACOC} = 5)

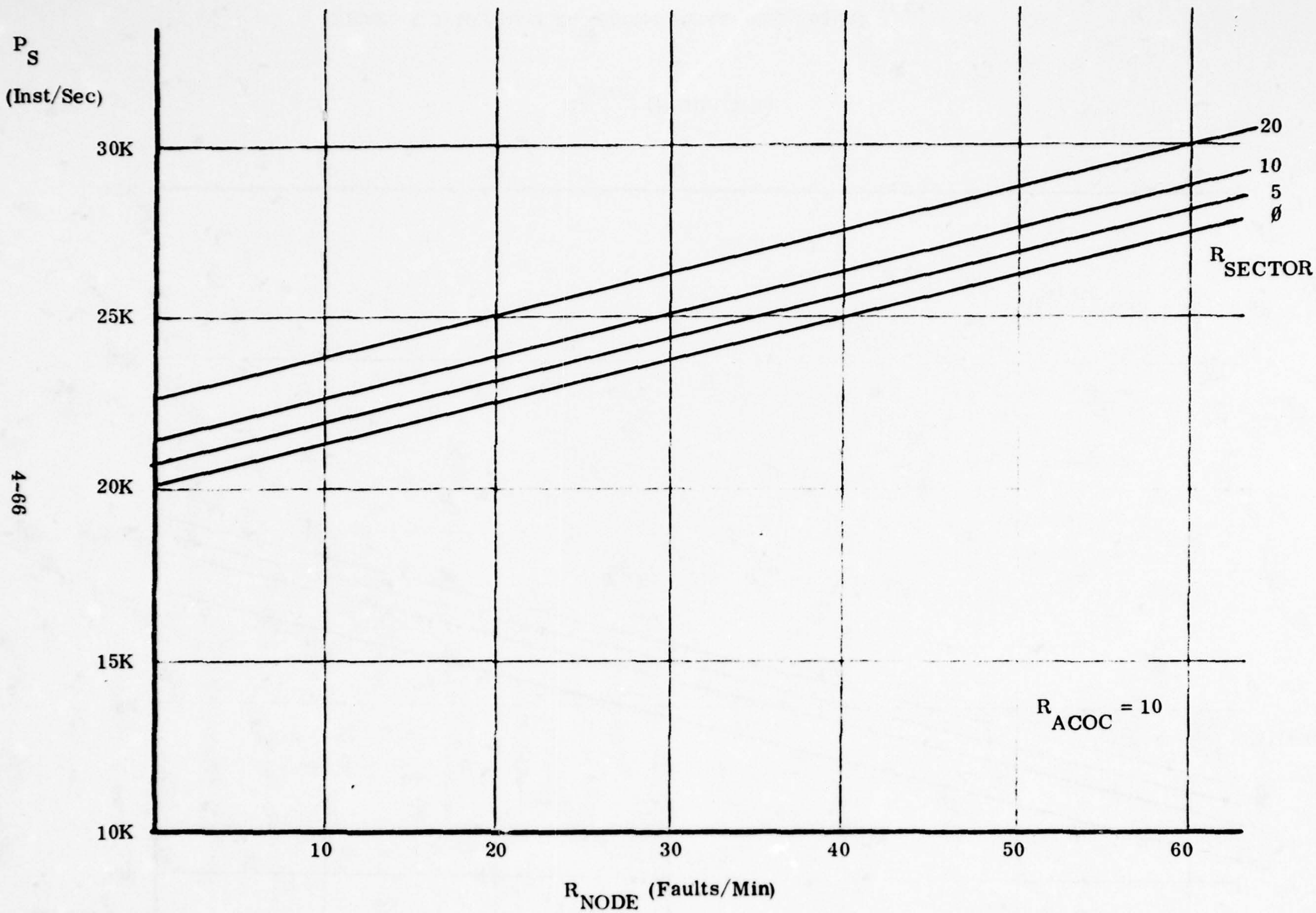


Figure 4.3-10 (Sheet 3). Sector Processing Load ($R_{ACOC} = 10$)

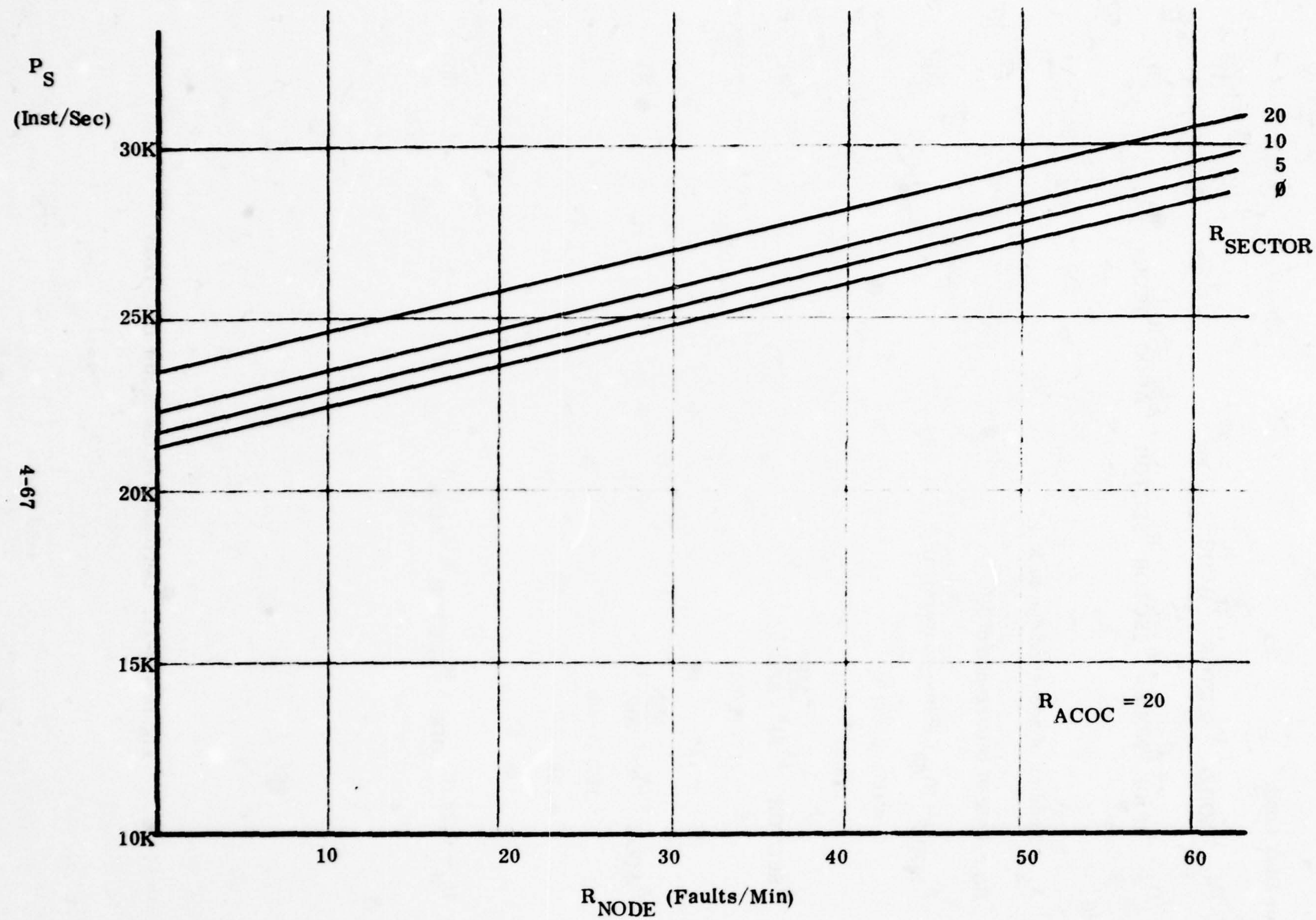


Figure 4.3-10 (Sheet 4). Sector Processing Load (R_{ACOC} =20)

Sector Disk Load:

$$D_S = D_{NODE} + D_{SECTOR} + D_{ACOC} \quad (1)$$

$$D_S = A_{NODE}\, R_{NODE} + A_{SECTOR}\, R_{SECTOR} + A_{ACOC}\, R_{ACOC} \quad (2)$$

where

A_X = Number of accesses due to X

R_X = Rate of occurrence of X

$$A_{NODE} = (A_{S3})\ (\text{Time conversion}) \quad (3)$$

$$= (17)\ (1/60)$$

$$= .28$$

$$A_{SECTOR} = (A_{S1})\ \left(\frac{MIN}{SEC}\right) \quad (4)$$

$$= (17)\ (1/60)$$

$$= .28$$

$$A_{ACOC} = (A_{S2})\ \left(\frac{MIN}{SEC}\right) \quad (5)$$

$$= (17)\ (1/60)$$

$$= .28$$

so

$$D_S = 0.28\ (R_{NODE} + R_{SECTOR} + R_{ACOC}) \quad (6)$$

Figure 4.3-11. Derivation of the Sector Disk Load

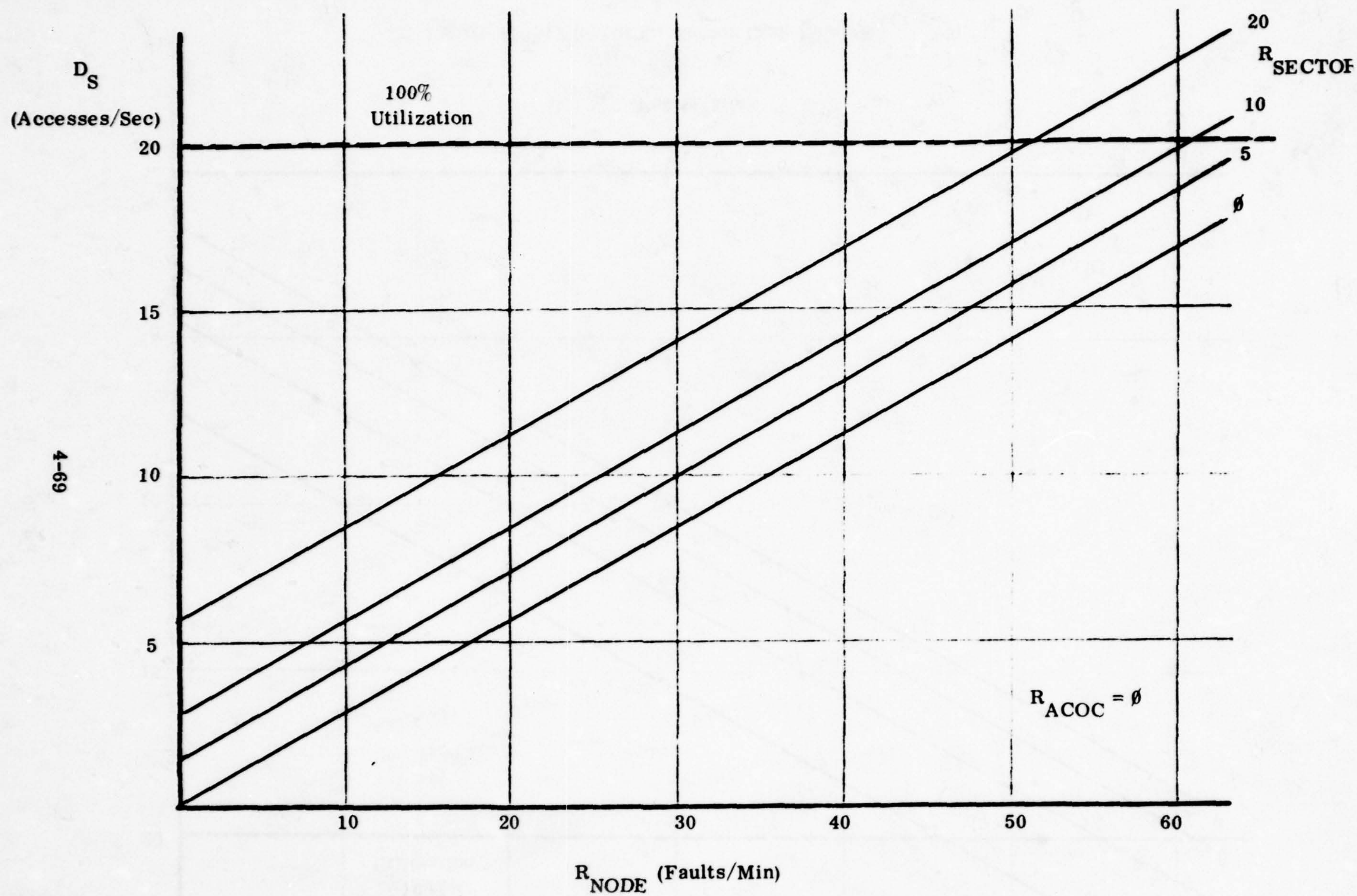


Figure 4.3-12 (Sheet 1). Sector Disk Load ($R_{ACOC} = 0$)

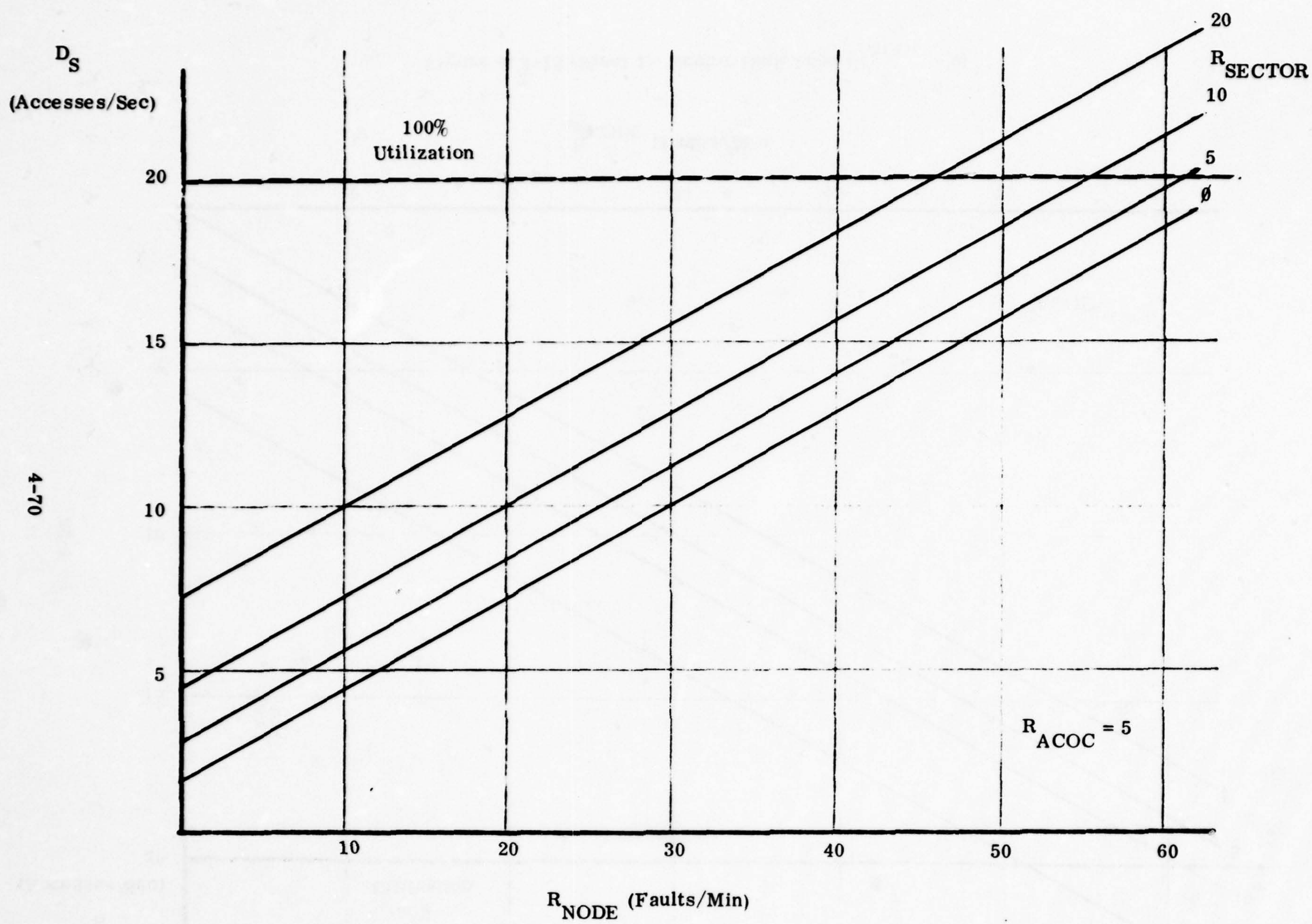


Figure 4.3-12 (Sheet 2). Sector Disk Load (R_{ACOC}=5)

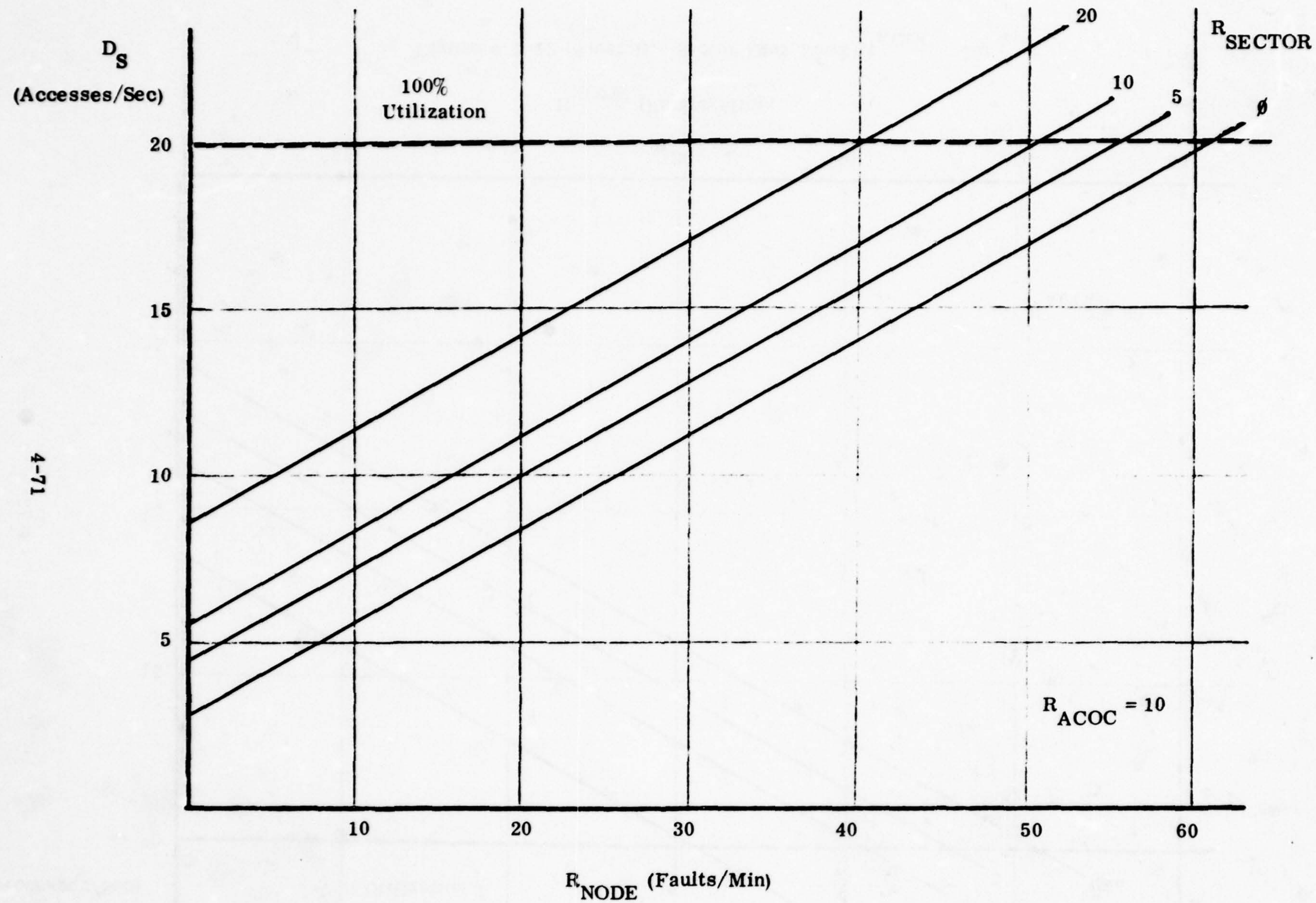


Figure 4.3-12 (Sheet 3). Sector Disk Load ($R_{ACOC} = 10$)

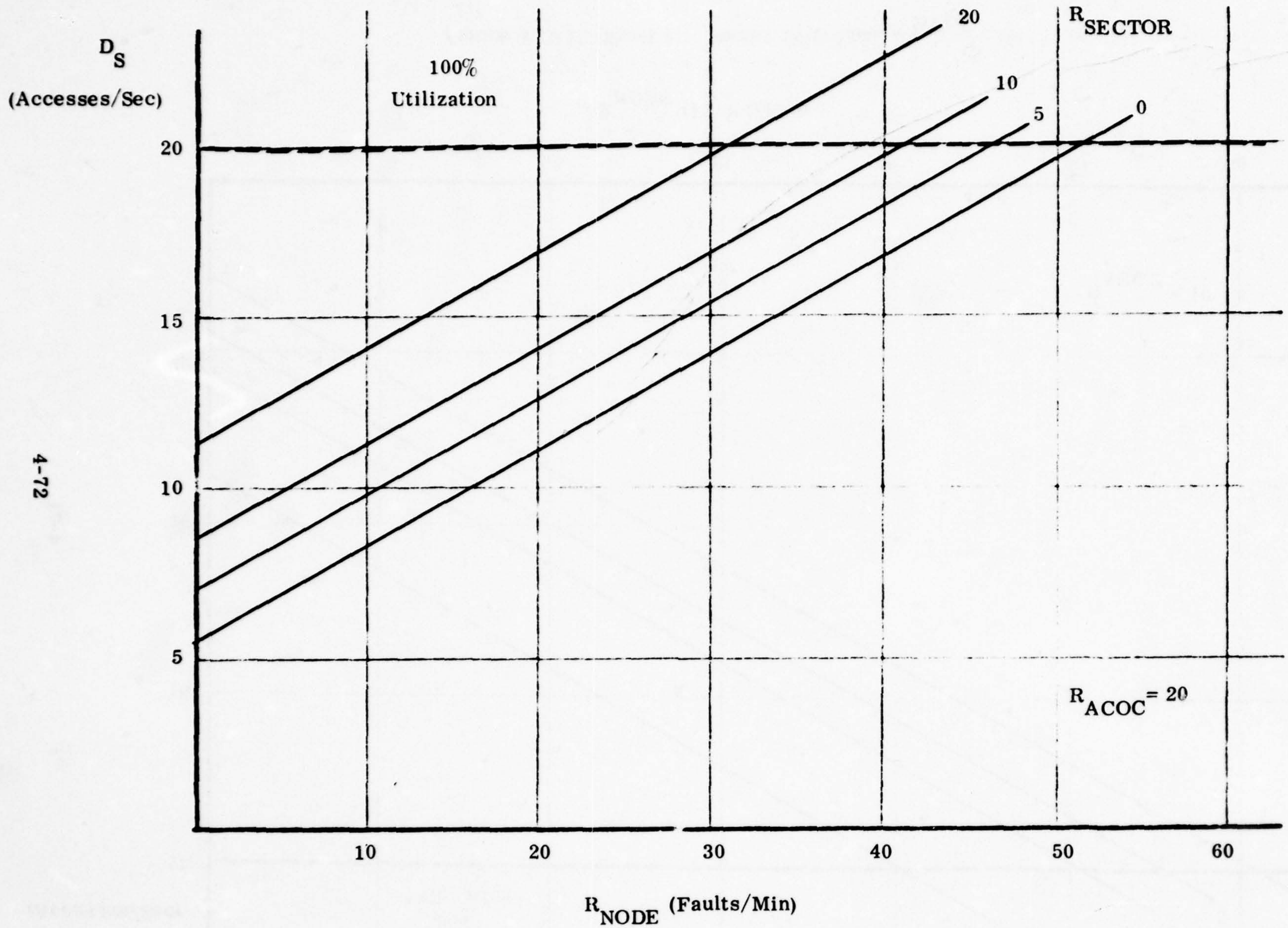


Figure 4.3-12 (Sheet 4). Sector Disk Load ($R_{ACOC} = 20$)

Table 4.3-1. Guide to Sector Level Detailed THREAD Diagrams

Element	Figure Containing Detailed Flow Diagrams
Supervisory and I/O Level	4.3-3
Sector Controller	4.3-4
Node	4.3-5
ACOC	4.3-6
Sector	4.3-7

Table 4.3-2. Sector Sizing Summary (Sheet 1 of 3)

PROGRAM NAME	FUNCTION	# INST HOL	PROG OCCUPANCY (Bytes)	DATA OCCUPANCY (Bytes)	COMMON	SECTOR CONT	SECTOR	ACOC	NODE					
Sector Supervisor	Controls all scheduled software activities	300	4500		X									
CRT I/O Driver	Performs CRT line handling	200	3000	2000	X									
Node I/O Driver	Performs Node line handling	100	1500	1000	X									
ACOC I/O Driver	Performs ACOC line handling	100	1500	1000	X									
Sector I/O Driver	Performs sector line handling	100	1500	1000	X									
Sector Controller Message Processor	Performs preliminary message processing of sector controller input	50	750			X								
Node Message Processor	Performs preliminary message processing of node input	50	750						X					
ACOC Message Processor (S)	Performs preliminary message processing of ACOC input	50	750				X							
Sector Message Processor (S)	Performs preliminary message processing of sector input	50	750					X						
Journal Inspection Processor	Controls retrieval of journal data for operator inspection	275	4125			X								
Fault Notification Broadcast Processor (S)	Supervises processing of fault notifications at the sector	300	4500		X									
Fault Update Broadcast Processor (S)	Supervises processing of fault updates at the sector	300	4500		X									
Fault Closure Broadcast Processor (S)	Supervises processing of fault closures at the sector	300	4500		X									
Broadcast Message Generator	Formats a broadcast message	100	1500		X									
Fault Summary Processor	Supervises summarization of outstanding faults	150	2250			X								
Fault Record Retrieve	Supervises retrieval of detailed fault records for display	50	750			X								
Sector Fault Retrieval Processor	Supervises retrieval of detailed fault records for other U.C. levels	75	1125		X									
Sector Fault Destination Processor	Supervises routing of detailed fault data to requesting position	50	750		X									
Sector Fault Update Processor	Supervises update of detailed fault data to requesting position	100	1500		X									
Fault Status Controller	Accept controller specivied changes in fault responsibility assignment	50	750			X								
Sector Fault Update	Supervises update of fault detail by sector controller	100	1500			X								
Sector Traffic Fault Processor	Accepts fault generated by ACOC traffic analysis	75	1125				X							
Connectivity Display Processor	Supervises retrieval and display of connectivity data	200	3000			X								
Connectivity Modification Processor	Supervises modification of connectivity	500	7500		X									
Connectivity Modification Request Proc (S)	Accepts controller requests for connectivity modifications	50	750			X								
Reroute Directive Processor	Forwards reroute directives to appropriate nodes	100	1500				X							
Reroute Request Processor	Accepts controller requests for reroute actions	50	750			X								
Reroute Confirmation Processor (S)	Supervises data base update upon confirmation receipt from sector/node	200	3000		X									
Media Status Retrieval Processor	Supervises media status retrieval for controller	250	3750		X									

Table 4.3-2. Sector Sizing Summary (Sheet 2 of 3)

PROGRAM NAME	FUNCTION	# INST HOL	PROG OCCUPANCY (Bytes)	DATA OCCUPANCY (Bytes)	COMMON	SECTOR CONT	SECTOR	ACOC	NODE
Sector PMP/QA Measurement Processor	Performs routing of PMP/QA data	50	750		X				
PMP/QA Request Processor	Accepts and forwards controller requests for PMP/QA data	50	750			X			
PMP/QA Gather	Forwards request for PMP/QA data to appropriate nodes	50	750				X		
Measurement Destination Processor	Performs routing of fault isolation measurements	50	750		X				
Manual Measurement Request Processor (S)	Accepts and forwards requests for manual FI measurements	50	750			X			
Automated Measurement Request Proc (S)	Accepts and forwards requests for automated FI measurements	50	750			X			
Sector Automated Measurement Processor	Receives and forwards automated fault isolation measurements	75	1125		X				
Sector Manual Measurement Processor	Receives and forwards manual fault isolation measurements	75	1125		X				
Free Text Message Processor	Supervises routing/display of free text messages	50	750		X				
HAZCON Processor	Supervises data base update upon receipt of a HAZCON	75	1125						X
Link Connectivity Retrieve	Performs link connectivity retrieval from media files	50	750		X				
VFCT Trunk Connectivity Retrieve	Performs VFCT trunk connectivity retrieval from media files	200	3000		X				
Trunk Connectivity Retrieve	Performs Trunk connectivity retrieval from media files	100	1500		X				
CCSD Connectivity Retrieve	Performs CCSD connectivity retrieval from media files	200	3000		X				
Link Connectivity Update	Performs link connectivity update in media files	100	1500		X				
VFCT Trunk Connectivity Update	Performs VFCT trunk connectivity update in media files	200	3000		X				
CCSD Connectivity Update	Performs CCSD connectivity update in media files	400	6000		X				
Trunk Connectivity Update	Performs trunk connectivity update in media files	200	3000		X				
Station Equipment Update	Performs station equipment file updates	100	1500					X	
Precedence Determine (S)	Determine precedence of a reported fault relative to current system status	400	6000		X				
Destination Processor	Determines routing for unified control messages	50	750		X				
Terminating Sector Determine	Determines the sector with jurisdiction over the terminating station for a circuit, trunk, or link	50	750		X				
Terminating Node Determine	Determines the node with jurisdication over the terminating station for a circuit, trunk, or link	50	750		X				
Destination Sector Determine	Determines all sectors with jurisdiction over a given circuit, trunk, or link	150	2250		X				
Destination Node Determine	Determines all nodes with jurisdiction over a given circuit, trunk, or link	150	2250		X				
Fault File Manager	Provides access to the fault file	150	2250		X				
Fault Summary Generator	Formats a fault summary line	50	750			X			

Table 4.3-2. Sector Sizing Summary (Sheet 3 of 3)

PROGRAM NAME	FUNCTION	# INST HOL	PROG OCCUPANCY (Bytes)	DATA OCCUPANCY (Bytes)	COMMON	SECTOR CONT	SECTOR	ACOC	NODE					
Associated Fault Purge	Performs purge processing of related faults upon closure	100	1500		X									
Journal Output Manager	Controls all output to the journal	50	750		X									
CRT Output Buffer Manager (S)	Controls all scheduled output to the controller position	100	1500		X									
Station File Manager	Provides access to the station file	175	2625		X									
Link File Manager	Provides access to the link file	175	2625		X									
Trunk File Manager	Provides access to the trunk file	150	2250		X									
VFCT Trunk Manager	Provides access to the VFCT trunk data	175	2625		X									
CCSD File Manager	Provides access to the CCSD file	200	3000		X									
Journal Input Manager	Processes all data into the journal	175	2625		X									
Journal Display Formatter	Formats data retrieved from the journal for display	100	1500			X								
Communications Message Formatter	Formats messages for data link transmission	150	2250		X									
Display File Manager	Performs retrieval of standard system displays	50	750		X									
Display Generator (S)	Parametrically builds system screen displays	50	750	300	X									
Fault File Search	Performs keyed searches of the fault file	75	1125		X									
Fault File Linkage Modification	Maintains Fault File linkage integrity	150	2250		X									
Fault Filter	Applies selection filters on fault data for summary display	50	750			X								
Related Fault Record Manager	Maintains related fault record linkage	50	750		X									
Sector Controller Decode/Valid.	Performs message type determination and validation	100	1500			X								
Message Type Decode	Performs communications message type determination	175	2625		X									
I/O Error Processor	Performs recovery processing upon communications error detection	150	2250		X									
Journal Block Formatter	Builds blocks of data for output to the journal	150	2250		X									
Communications Buffer Manager	Maintains the data link I/O buffers	100	1500		X									
Communications Message File Manager	Performs retrieval of standard system communications messages	50	750		X									
CRT Buffer Manager	Maintains the CRT input buffers	75	1125		X									
FIND	Performs generic data base maintenance processing	500	7500		X									
CREATE	Performs generic data base maintenance processing	500	7500		X									
GET	Performs generic data base maintenance processing	500	7500		X									
DELETE	Performs generic data base maintenance processing	500	7500		X									
MODIFY	Performs generic data base maintenance processing	500	7500		X									

Total Lines of Code - 12,825
Total Program Occupancy - 192,375
Total Data Occupancy - 5,300 bytes

Table 4.3-3. Sector Resident and Support Overlay Sizing Summary (Sheet 1 of 2)

PROGRAM NAME	FUNCTION	# INST HOL	PROG OCCUPANCY (Bytes)	DATA OCCUPANCY (Bytes)	RESIDENT	SEC CONT SUPP	SECTOR SUPPORT	ACOC SUPPORT	NODE SUPPORT
Sector Supervisor	Controls all scheduled software activities	300	4500		X				
CRT I/O Driver	Performs CRT line handling	200	3000	2000	X				
Node I/O Driver	Performs Node line handling	100	1500	1000	X				
ACOC I/O Driver	Performs ACOC line handling	100	1500	1000	X				
Sector I/O Driver	Performs sector line handling	100	1500	1000	X				
Sector Controller Message Processor	Performs preliminary message processing of sector controller input	50	750			X			
Node Message Processor	Performs preliminary message processing of node input	50	750						X
ACOC Message Processor (S)	Performs preliminary message processing of ACOC input	50	750					X	
Sector Message Processor (S)	Performs preliminary message processing of sector input	50	750				X		
Broadcast Message Generator	Formats a broadcast message	100	1500		X				
Station Equipment Update	Performs station equipment file updates	100	1500					X	
Destination Processor	Determines routing for unified control messages	50	750		X				
Terminating Sector Determine	Determines the sector with jurisdiction over the terminating station for a circuit, trunk, or link	50	750		X				
Terminating Node Determine	Determines the node with jurisdiction over the terminating station for a circuit, trunk, or link	50	750		X				
Destination Sector Determine	Determines all sectors with jurisdiction over a given circuit, trunk, or link	150	2250					X	X
Destination Node Determine	Determines all nodes with jurisdiction over a given circuit, trunk, or link	150	2250				X	X	X
CRT Output Buffer Manager (S)	Controls all scheduled output to the controller position	100	1500		X				
Station File Manager	Provides access to the station file	175	2625		X				
Link File Manager	Provides access to the link file	175	2625		X				
Trunk File Manager	Provides access to the trunk file	150	2250		X				
VFCT Trunk Manager	Provides access to the VFCT trunk data	175	2625		X				
CCSD File Manager	Provides access to the CCSD file	200	3000		X				
Journal Input Manager	Processes all data into the journal	175	2625			X			
Communications Message Formatter	Formats messages for data link transmission	150	2250		X				
Display File Manager	Performs retrieval of standard system displays	50	750		X				
Display Generator (S)	Parametrically builds system screen displays	50	750	300	X				
Sector Controller Decode/Valid.	Performs message type determination and validation	100	1500			X			

Table 4.3-3. Sector Resident and Support Overlay Sizing Summary (Sheet 2 of 2)

PROGRAM NAME	FUNCTION	# INST HOL	PROG OCCUPANCY (Bytes)	DATA OCCUPANCY (Bytes)	RESIDENT	SEC CONT SUPP	SECTOR SUPPORT	ACOC SUPPORT	NODE SUPPORT
Message Type Decode	Performs communications message type determination	175	2625				X	X	X
I/O Error Processor	Performs recovery processing upon communications error detection	150	2250				X	X	X
Journal Block Formatter	Builds blocks of data for output to the journal	150	2250			X			
Communications Buffer Manager	Maintains the data link I/O buffers	100	1500		X				
Communications Message File Manager	Performs retrieval of standard system communications messages	50	750			X		X	X
CRT Buffer Manager	Maintains the CRT input buffers	75	1125			X			
FIND	Performs generic data base maintenance processing	500	7500		X				
CREATE	Performs generic data base maintenance processing	500	7500		X				
GET	Performs generic data base maintenance processing	500	7500		X				
DELETE	Performs generic data base maintenance processing	500	7500		X				
MODIFY	Performs generic data base maintenance processing	500	7500		X				
TOTAL OCCUPANCY					78425	9000	7875	12375	10875

Table 4.3-4. Sector Functional Overlay Structure Sizing Summary (Sheet 1 of 6)

			SECTOR CONTROLLER																	
PROGRAM NAME	NO. INST HOL	Program Occupancy (Bytes)	Journal Inspection	Fault Summarization	Fault Record Retrieval	Fault Status Controller	Fault Update	Connectivity Display	Connectivity Mod. Request	Reroute Request	Media Status Retrieval	PMP/QA Data Request	Manual Measurement Req	Automated Measurement Req	Free Text Msg Processing					
Journal Inspection Processor	275	4125	X																	
Fault Notification Broadcast Processor (S)	300	4500																		
Fault Update Broadcast Processor (S)	300	4500																		
Fault Closure Broadcast Processor (S)	300	4500																		
Broadcast Message Generator	100	1500					X													
Fault Summary Processor	150	2250		X																
Fault Record Retrieve	50	750			X															
Sector Fault Retrieval Processor	75	1125																		
Sector Fault Destination Processor	50	750																		
Sector Fault Update Processor	100	1500																		
Fault Status Controller	50	750				X														
Sector Fault Update	100	1500					X													
Sector Traffic Fault Processor	75	1125																		
Connectivity Display Processor	200	3000						X												
Connectivity Modification Processor (S)	500	7500																		
Connectivity Modification Request Proc (S)	50	750							X											
Reroute Directive Processor	100	1500																		
Reroute Request Processor	50	750								X										
Reroute Confirmation Processor (S)	200	3000																		
Media Status Retrieval Processor	250	3750									X									
Sector PMP/QA Measurement Processor	50	750																		
PMP/QA Request Processor	50	750										X								
PMP/QA Gather	50	750																		
Measurement Destination Processor	50	750																		
Manual Measurement Request Processor (S)	50	750											X							
Automated Measurement Request Processor (S)	50	750												X						
Sector Automated Measurement Processor	75	1125																		
Sector Manual Measurement Processor	75	1125																		
Free Text Message Processor	50	750													X					

Table 4.3-4. Sector Functional Overlay Structure Sizing Summary (Sheet 2 of 6)

			SECTOR CONTROLLER												
PROGRAM NAME	NO. INST HOL	Program Occupancy (Bytes)	Journal Inspection	Fault Summarization	Fault Record Retrieval	Fault Status Controller	Fault Update	Connectivity Display	Connectivity Mod. Request	Reroute Request	Media Status Retrieval	PMP/QA Data Request	Manual Measurement Req	Automated Measurement Req	Free Text Msg Processing
HAZCON Processor	75	1125													
Link Connectivity Retrieve	50	750						X							
VFCT Trunk Connectivity Retrieve	200	3000						X							
Trunk Connectivity Retrieve	100	1500						X							
CCSD Connectivity Retrieve	200	3000						X							
Link Connectivity Update	100	1500													
VFCT Trunk Connectivity Update	200	3000													
CCSD Connectivity Update	400	6000													
Trunk Connectivity Update	200	3000													
Station Equipment Update	100	1500													
Precedence Determine (S)	400	6000													
Fault File Manager	150	2250		X	X	X	X								
Fault Summary Generator	50	750		X											
Associated Fault Purge	100	1500													
Journal Output Manager	50	750	X												
Journal Display Formatter	100	1500	X												
Fault File Search	75	1125		X	X	X	X								
Fault File Linkage Modification	150	2250				X	X								
Fault Filter	50	750		X											
Related Fault Record Manager	50	750		X	X		X								
Total Occupancy			6375	7875	4875	6375	9375	11250	750	750	3750	750	750	750	750

Table 4.3-4. Sector Functional Overlay Structure Sizing Summary (Sheet 3 of 6)

			SECTOR											ACOC						
PROGRAM NAME	NO INST HOL	Program Occupancy (bytes)	Fault Notification Broadcast	Fault Update Broadcast	Fault Closure Broadcast	Sector Fault Retrieval	Sector Fault Destination	Connectivity Modification	Reroute Confirmation	Sector PMP QA Measurements	PMP/QA Gather	Measurement Destination Proc	Free Text Msg Processing	Sector Fault Retrieval	Sector Fault Destination	Sector Traffic Faults	Connectivity Mod Request	Reroute Directive	PMP/QA Gather	Free Text Msg Processing
Journal Inspection Processor	275	4125																		
Fault Notification Broadcast Processor (S)	300	4500	X																	
Fault Update Broadcast Processor (S)	300	4500		X																
Fault Closure Broadcast Processor (S)	300	4500			X															
Broadcast Message Generator	100	1500	X	X	X											X				
Fault Summary Processor	150	2250																		
Fault Record Retrieve	50	750																		
Sector Fault Retrieval Processor	75	1125				X								X						
Sector Fault Destination Processor	50	750					X								X					
Sector Fault Update Processor	100	1500																		
Fault Status Controller	50	750																		
Sector Fault Update	100	1500																		
Sector Traffic Fault Processor	75	1125														X				
Connectivity Display Processor	200	3000																		
Connectivity Modification Processor	500	7500						X												
Connectivity Modification Request Proc (S)	50	750															X			
Reroute Directive Processor	100	1500																X		
Reroute Request Processor	50	750																		
Reroute Confirmation Processor (S)	200	3000							X											
Media Status Retrieval Processor	250	3750																		
Sector PMP/QA Measurement Processor	50	750								X										
PMP/QA Request Processor	50	750																		
PMP/QA Gather	50	750									X								X	
Measurement Destination Processor	50	750										X								
Manual Measurement Request Processor (S)	50	750																		
Automated Measurement Request Processor (S)	50	750																		
Sector Automated Measurement Processor	75	1125																		
Sector Manual Measurement Processor	75	1125																		
Free Text Message Processor	50	750											X							X

Table 4.3-4. Sector Functional Overlay Structure Sizing Summary (Sheet 4 of 6)

			SECTOR											ACOC						
PROGRAM NAME	NO. INST HOL	Program Occupancy (bytes)	Fault Notification Broadcast	Fault Update Broadcast	Fault Closure Broadcast	Sector Fault Retrieval	Sector Fault Destination	Connectivity Modification	Reroute Confirmation	Sector PMP QA Measurements	PMP QA Gather	Measurement Destination Proc	Free Text Msg Processing	Sector Fault Retrieval	Sector Fault Destination	Sector Traffic Faults	Connectivity Mod Request	Reroute Directive	PMP/QA Gather	Free Text Msg Processing
HAZCON Processor	75	1125																		
Link Connectivity Retrieve	50	750																		
VFCT Trunk Connectivity Retrieve	200	3000																		
Trunk Connectivity Retrieve	100	1500																		
CCSD Connectivity Retrieve	200	3000																		
Link Connectivity Update	100	1500						X												
VFCT Trunk Connectivity Update	200	3000						X												
CCSD Connectivity Update	400	6000						X												
Trunk Connectivity Update	200	3000						X												
Station Equipment Update	100	1500						X												
Precedence Determine (S)	400	6000	X	X	X															
Fault File Manager	150	2250	X	X	X		X		X							X				
Fault Summary Generator	50	750																		
Associated Fault Purge	100	1500			X															
Journal Output Manager	50	750																		
Journal Display Formatter	100	1500																		
Fault File Search	75	1125	X	X	X		X		X							X				
Fault File Linkage Modification	150	2250	X	X	X		X		X							X				
Fault Filter	50	750																		
Related Fault Record Manager	50	750	X	X	X		X		X							X				
Total Occupancy			18375	18375	19875	1125	7125	22500	9375	750	750	750	750	1125	750	9000	750	1500	750	750

Table 4.3-4. Sector Functional Overlay Structure Sizing Summary (Sheet 5 of 6)

PROGRAM NAME	NO INST HOL	Program Occupancy (bytes)	NODE: Fault Notification Broadcast	Fault Update Broadcast	Fault Closure Broadcast	Sector Fault Destination	Sector Fault Update	Connectivity Modification	Reroute Confirmation	Sector PMP/QA Measurements	Sector Automated Measurements	Sector Manual Measurements	Free Text Msg Processing	HAZCON Message	Sector Fault Retrieval					
Journal Inspection Processor	275	4125																		
Fault Notification Broadcast Processor (S)	300	4500	X																	
Fault Update Broadcast Processor (S)	300	4500		X																
Fault Closure Broadcast Processor (S)	300	4500			X															
Broadcast Message Generator	100	1500	X	X	X									X						
Fault Summary Processor	150	2250																		
Fault Record Retrieve	50	750																		
Sector Fault Retrieval Processor	75	1125													X					
Sector Fault Destination Processor	50	750				X														
Sector Fault Update Processor	100	1500					X													
Fault Status Controller	50	750																		
Sector Fault Update	100	1500																		
Sector Traffic Fault Processor	75	1125																		
Connectivity Display Processor	200	3000																		
Connectivity Modification Processor	500	7500						X												
Connectivity Modification Req Processor (S)	50	750																		
Reroute Directive Processor	100	1500																		
Reroute Request Processor	50	750																		
Reroute Confirmation Processor (S)	200	3000							X											
Media Status Retrieval Processor	250	3750																		
Sector PMP/QA Measurement Processor	50	750								X										
PMP/QA Request Processor	50	750																		
PMP/QA Gather	50	750																		
Measurement Destination Processor	50	750																		
Manual Measurement Request Processor (S)	50	750																		
Automated Measurement Req Processor (S)	50	750																		
Sector Automated Measurement Processor	75	1125									X									
Sector Manual Measurement Processor	75	1125										X								
Free Text Message Processor	50	750											X							

Table 4.3-4. Sector Functional Overlay Structure Sizing Summary (Sheet 6 of 6)

PROGRAM NAME	NO. INST HOL	Program Occupancy (bytes)	NODE												
			Fault Notification Broadcast	Fault Update Broadcast	Fault Closure Broadcast	Sector Fault Destination	Sector Fault Update	Connectivity Modification	Reroute Confirmation	Sector PMP QA Measurements	Sector Automated Measurements	Sector Manual Measurements	Free Text Msg Processing	HAZCON Message	Sector Fault Retrieval
HAZCON Processor	75	1125												X	
Link Connectivity Retrieve	50	750													
VFCT Trunk Connectivity Retrieve	200	3000													
Trunk Connectivity Retrieve	100	1500													
CCSD Connectivity Retrieve	200	3000													
Link Connectivity Update	100	1500						X							
VFCT Trunk Connectivity Update	200	3000						X							
CCSD Connectivity Update	400	6000						X							
Trunk Connectivity Update	200	3000						X							
Station Equipment Update	100	1500						X							
Precedence Determine (S)	400	6000	X	X	X										
Fault File Manager	150	2250	X	X	X	X	X		X						
Fault Summary Generator	50	750													
Associated Fault Purge	100	1500			X										
Journal Output Manager	50	750													
Journal Display Formatter	100	1500													
Fault File Search	75	1125	X	X	X	X	X		X						
Fault File Linkage Modification	150	2250	X	X	X	X	X		X						
Fault Filter	50	750													
Related Fault Record Manager	50	750	X	X	X	X	X		X						
Total Occupancy			18375	18375	19875	7125	7875	22500	9375	750	1125	1125	750	1125	1125

Table 4.3-5. Determination of the Largest Memory Requirement for the Sector

Element	*Resident* Routines	*Support* Overlay	*Largest* Functional Overlay	Total Occupancy
Sector Controller	78,425	9,000	11,250	98,675
Sector	78,425	7,875	22,500	108,800
ACOC	78,425	12,375	9,375	100,175
NODE	78,425	10,875	22,500	111,800

Table 4.3-6. Summary of Algorithms for the Sector

Algorithm	Function	# ASM Inst	# Disk Accesses
S1	Process Fault Notification Broadcast from Sectors	2288	17
S2	Process Fault Notification Broadcast from ACOC	2288	17
S3	Process Fault Notification Broadcast from Nodes	2768	17
S4	Sector Controller Request for CCSD Connectivity Display	18012	16

Table 4.3-7. Sector I/O Load

Source	No. Lines	Line Rate (bps)	# Byte Transfer/ Sec/Line	Aggregate Transfer/ Sec	Load/ Transfer (Inst.)	Aggregate Load (Inst.)
ACOC	1 1/	2400	300	600 1/	3	1800
SECTOR	4 1/	2400	300	2400 1/	3	7200
NODE	5 1/	2400	300	3000 1/	3	9000
SECTOR CONTROLLER	2	2400	300	600	3	900

TOTAL I/O LOAD - 18,900 inst/sec

1/ Full Duplex

4.4 HARDWARE CONSIDERATIONS FOR THE SECTOR

In the following subsections the hardware considerations for the Sector level of unified control including processor, peripheral equipment, and processor interface characteristics are addressed.

4.4.1 Sector Processor

The Sector processing system as described in Section 4.3 primarily performs data base management and display processing functions. A basic characteristic of such functions is that they are highly I/O bound by disk and terminal access requirements as demonstrated by the load analysis presented in Paragraph 4.3.3. In addition, the Sector performs message routing for messages defined for other system elements. Assuming the Sector software to be implemented in a multi-programmed environment, a task switching overhead may be applied in a manner similar to that presented in Paragraph 3.4.1 for the Node. Using an estimate of 1 millisecond/switch the Sector task overhead is determined to be 70 milliseconds (70 fault notifications @ 1 millisecond/switch). The sustained Sector load is presented for three classes of 16-bit word length minicomputers below:

8 microsecond average instruction time - 0.217
5 microsecond average instruction time - 0.136
2.5 microsecond average instruction time - 0.069

The relatively low bandwidth of processing requirements at the Sector is apparent from this data. At these bandwidths, although the Sector is more heavily loaded than the Node, processor speed is not a critical factor in performing real time functions.

The processor memory requirement for the Sector is estimated to be 124K bytes (Paragraph 4.3.2). The Sector processor should at a minimum support a memory configuration adequate to satisfy this requirement and should provide for future memory growth of 100% to allow for functional expansion of Sector capabilities.

The general hardware and support software considerations discussed in Paragraph 3.4.1 for the Node apply to the Sector level of unified control as well, due to the functional similarities between the two elements.

4.4.2 Sector Peripherals and Interfaces

Figure 4.4-1 shows the hardware configuration for the Sector which includes a processor configured with a minimum of 128K bytes of main memory, 10M bytes of random access disk storage for data base and program overlay storage, a magnetic tape unit for long term journal retention, and as many as two KB/CRT terminals with local hard copy capabilities to support Sector Controller positions. Communications between the ACOC and Nodes and the Sector are provided by a total of 10 2400 bps serial synchronous data channels.

The data base storage requirement at the Sector is estimated to be 6.3M bytes (Section 4.2). In order to provide adequate space for applications and support software a disk capacity no less than 10M bytes should be supplied. Because of the high disk utilization at the Sector, the average access time for the device should be less than 50 milliseconds.

The magnetic tape unit should be compatible with the Node and ACOC tape units to minimize logistic and maintenance related costs. Further, the compatability would allow batch reduction of journal data to be accomplished in a single facility for the entire system.

The highly interactive nature of Sector Controller activity requires that a powerful KB/CRT terminal be used to support this position. The required capabilities of this terminal are the same as those described for the Node terminals (Paragraph 3.4.2).

In order to provide compatability among all internal unified control communications interfaces, the synchronous channels for the Sector should have the same capabilities as the channels described for use at the Node (Paragraph 3.4.2).

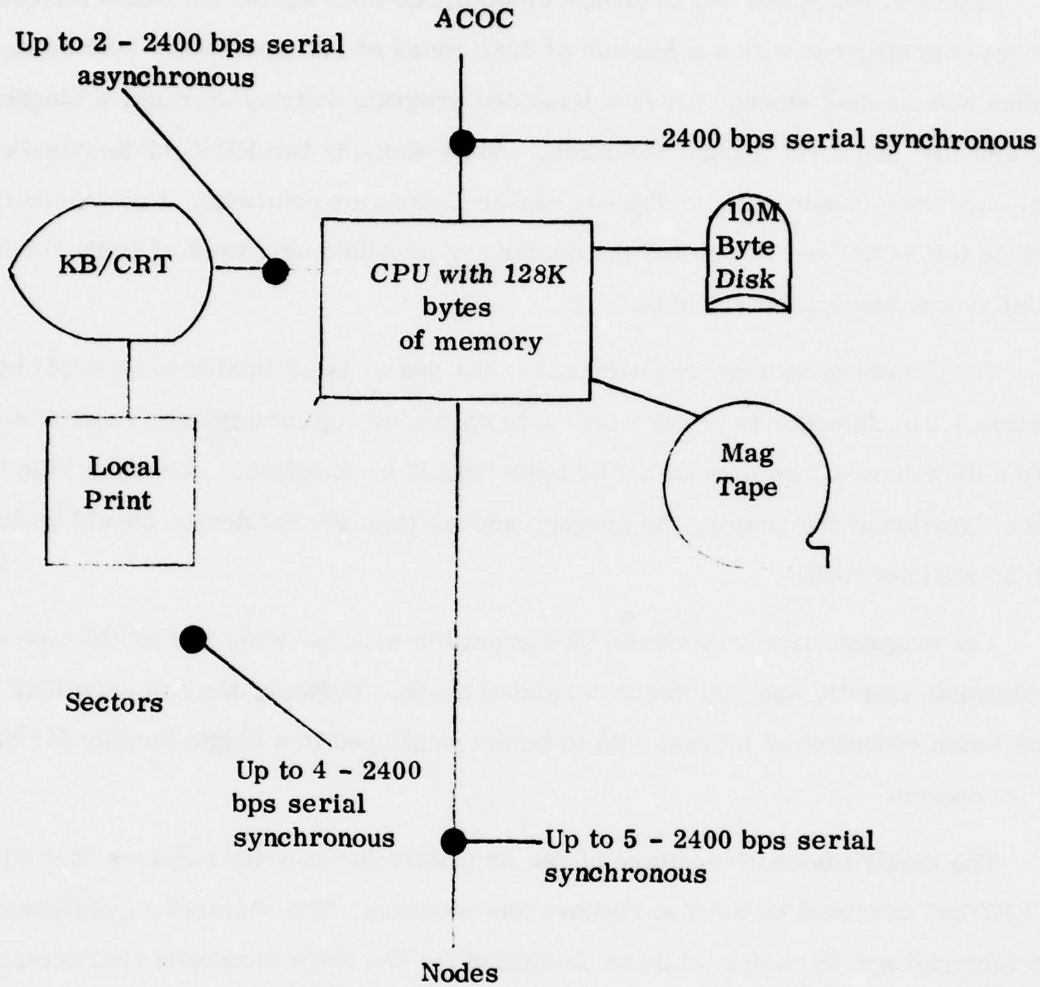


Figure 4.4-1. Sector Hardware Configuration

SECTION 5 - ACOC REQUIREMENTS

5.1 FUNCTIONAL DESCRIPTION

This functional description encompasses the function performed at the ACOC level of the unified control system. In the detailed flowcharts that follow many connections between pages were required because of the complexity of the diagrams. A continuation to or from a different page is shown by a circle with a number in it. The numbering system is the same as that used on the general flowchart. If a circle contains A3-1 the flow continues on Sheet 3 of the ACOC level flowchart, the second number distingishing different inputs on the same page. A single circle indicates the flow is information only, and two concentric circles indicates that the flow is control and direction as well as information.

The majority of the functions illustrated within the ACOC level are envisioned as being automatically processed. At several points, however, operator intervention is required. This is indicated within the flowcharts by the dashed lines.

Figure 5.1-1 is the functional flowchart for the ACOC. Sheet 1 shows the information flow at the ACOC of the combined system status received from the sectors. This information updates the data base (A), along with inputs entered by the SATCOM controller concerning satellite link problems (B). If the report is on a hazardous condition at a station (C), the information will be displayed to the network controller as it is received (D).

The ACOC will determine if the report could affect any links, trunks, or circuits outside of the theater (E). If so, the other theater involved will be informed of the problem (F). Next, the ACOC will determine if the fault could affect any AUTODIN IST's or access lines (G). If this is possible, the status information is displayed to the AUTODIN controller (H) to assist in making control decisions as described on Sheet 2. The report is then examined to identify any AUTOVON IST groups or

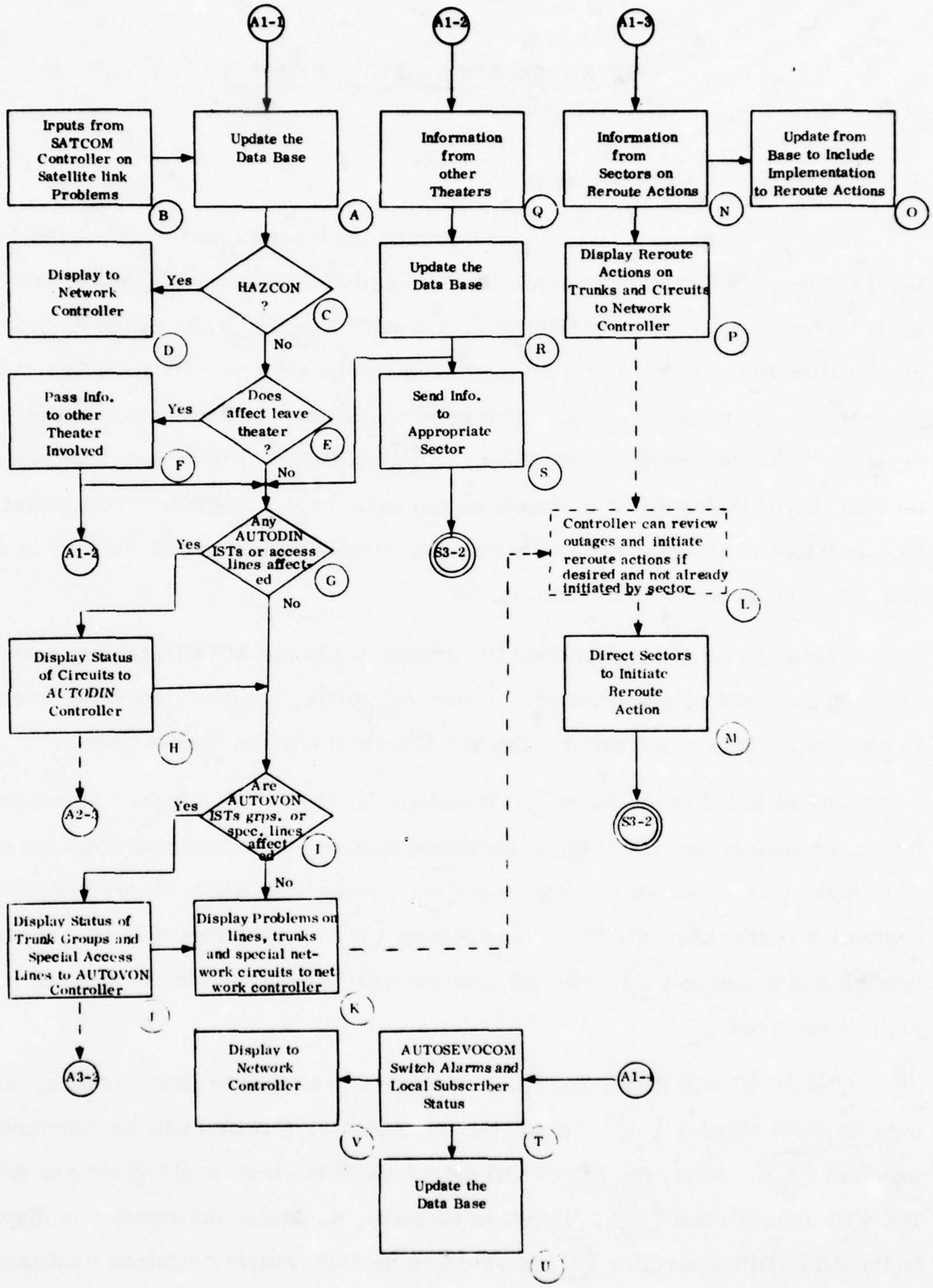


Figure 5.1-1. ACOC Level Functional Flowchart (Sheet 1 of 3)

special lines that may be affected (I). If any are, the status is displayed to the AUTOVON controller (J), as for AUTODIN, to give the controller the current circuit status to help make the most appropriate control decisions.

Problems reported on links, trunks, or circuits of special interest to the ACOC are automatically displayed to the network controller (K). The controller can review the information (L) and direct the sectors to implement a reroute (M), if they have not already done so. The sectors inform the ACOC of all reroute actions taken (N), and the network controller is kept informed of reroutes by receiving displays of the information when it is reported (P). The status of all reroute actions is stored in the data base (O) and is available to the controller upon request.

Information is received at the ACOC from other theaters on the status of inter-theater links, trunks, and circuits (Q). This information updates the data base (R) and is distributed to the appropriate sector (S). The routine is also entered to determine if AUTODIN or AUTOVON could be affected and to display the status to the controllers as required.

Switch alarms and local subscriber status received from AUTOSEVOCOM switch stations (T) is stored within the ACOC data base (U). Displays are presented as reports are received to keep the network controller aware of the status of the switch stations (V). Serious outage conditions would prompt the controller to investigate possible restoral actions. The controller will also be capable of requesting status information from the data base to assist in responding to inquiries from users about service degradations.

Sheet 2 of the flowchart shows the information flow from the AUTODIN switch station inputs. AUTODIN switch alarm indications (A) are stored in the data base (B). Major equipment problems, affecting switch throughput, are displayed to the AUTODIN controller (C).

Periodic system status summaries from the switch stations (D) are stored in the ACOC data base (E). Only the most recent system STAT is kept. When a new

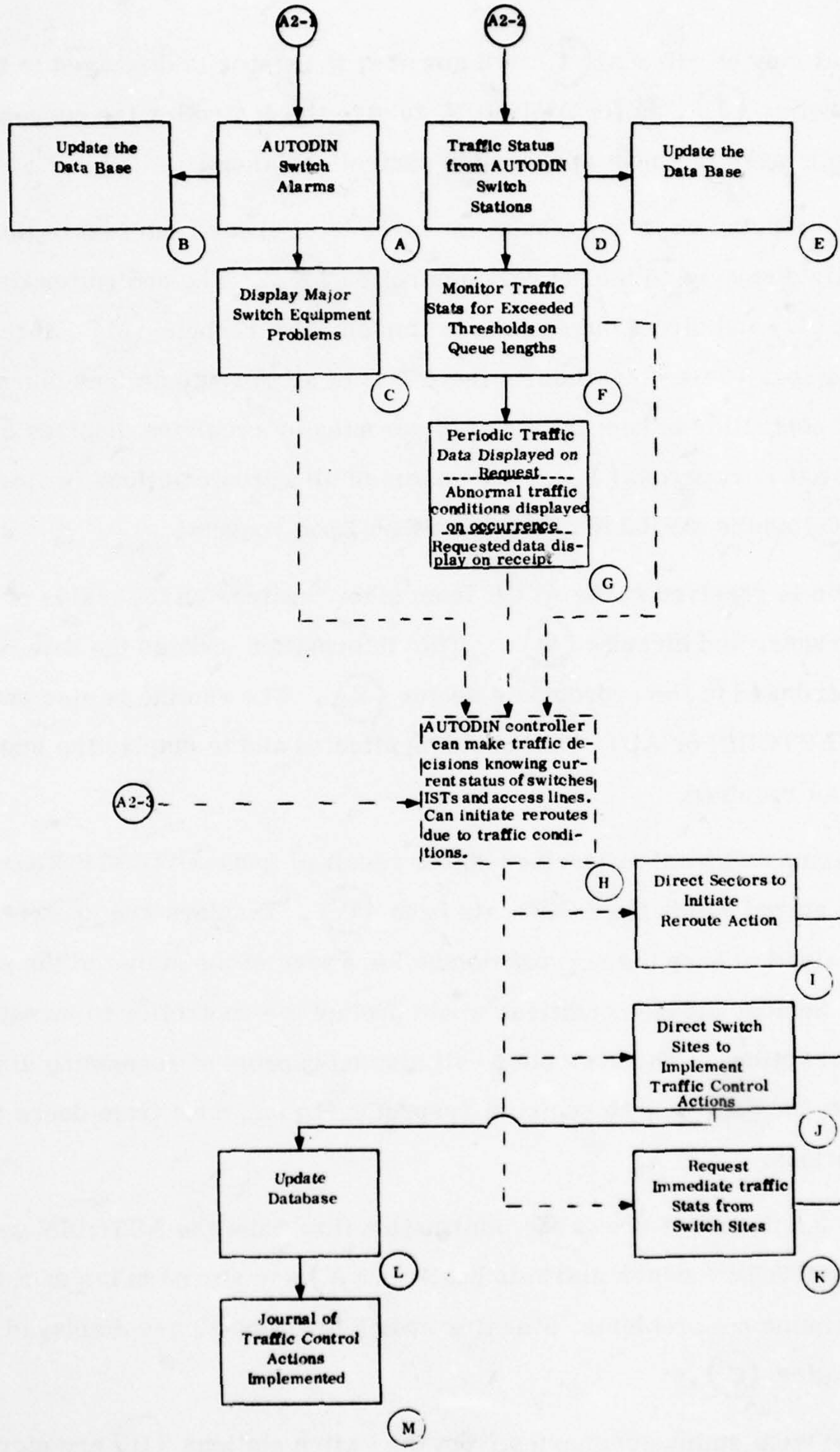


Figure 5.1-1. ACOC Level Functional Flowchart (Sheet 2 of 3)

report is received, the old data is journaled. After each new summary STAT is received, the queue lengths on each channel are scanned for any that exceed the thresholds established by the ACOC F . Any channel above a threshold is immediately displayed to the controller. Other STAT reports from the switches are journaled as they are received.

The periodic traffic data stored within the data base will normally be displayed upon request from the controller. Any traffic data that has been sent to the ACOC because of an abnormal condition will be displayed upon receipt, as will data requested from the stations by the AUTODIN controller G .

This information being presented, along with the current combined system status that is being displayed (from Sheet 1) allows the AUTODIN controller to make traffic control decisions knowing the current status of switches, IST's, and access lines H . The controller can also direct the transmission system to implement a reroute to alleviate a traffic backlog condition on a degraded circuit I. Requests can be made of the switch station for more traffic information K , and the controller will instruct the switch stations to implement traffic control actions J . Control actions that are implemented will be stored in the data base L and, as the controls are deleted, the entries will be removed from the data base and entered into a journal record M .

Sheet 3 shows the information flow from the AUTOVON switch stations. Equipment status and call processing data reduced at the switch stations are received A and stored in the ACOC data base B . This information from all of the switch stations is evaluated further C and any abnormal condition affecting network performance will be displayed to the controller D , along with suggested control actions to help alleviate the problem. This information being presented, along with the current combined system status that is being displayed (from Sheet 1) allows the AUTOVON controller to make traffic control decisions knowing the current status of switches IST's, and special interest circuits E .

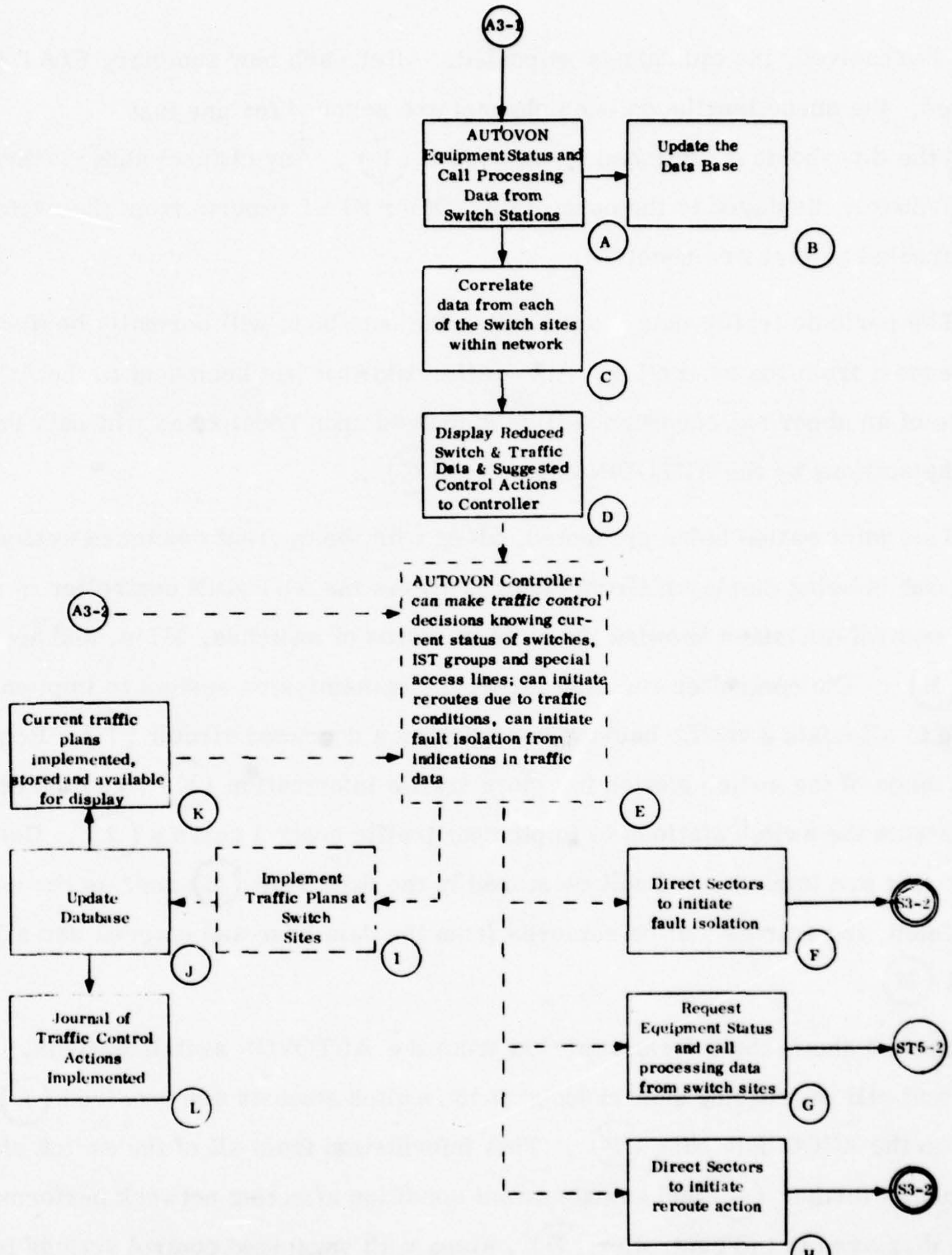


Figure 5.1-1. ACOC Level Functional Flowchart (Sheet 3 of 3)

The controller can direct the transmission system to implement reroutes to alleviate traffic congestion due to a degraded trunk group (H) . The controller can also direct the sector to initiate transmission fault isolation if required and not already in progress (F) . Requests can be made of the switch station for more status information if required (G) , and the controller will implement traffic control actions (I). Control actions that are implemented will be stored in the data base (J) and will be displayed (K) to keep the controller aware of the current network configuration. As control actions are deleted, the data base will be updated (J) , and the information will be entered into a journal record (L) .

5.2 ACOC DATA BASE DESCRIPTION

The following paragraphs describe the ACOC level data base in terms of its structure, content and sizing requirements.

5.2.1 Structure

In support of the unified control effort at the ACOC level, sixteen data files were created. These files include Sector, Node, Station, Link, Trunk and CCSD masters, a fault master and a related fault detail, AUTODIN and AUTOSEVOCOM station details, and five AUTOVON files. Figure 5.2-1 pictures graphically the data base structure. The linkages among data sets indicate that the detail data set records can be accessed through master record pointers. In this case, a chain of fault detail records can be retrieved for each Node, responsible station, link, trunk, CCSD or fault ID and chains of related fault records can be read for each fault ID. In addition, station status and traffic detail records can be accessed through the station master pointers.

5.2.2 Content

Tables 5.2-1 through 5.2-16 describe the content and format of each data file within the ACOC level data base.

The connectivity for each station, link, trunk and circuit within the theater is provided in each of the respective master data files. A status summary or "degree of degradation" is also provided in these files. As faults on link, trunk and special circuits are reported to the ACOC, these status files are updated with the current status. The detailed fault record, generated from a trouble report, is added to the ACOC data base. Any additional trouble reports on the same problem will cause related fault file records to be added to the data base and linked to the detailed fault record.

Equipment status and traffic trouble indicators are provided in the five AUTOVON files which basically maintain status of out-of-threshold conditions as determined at the AUTOVON switch station level module.

Finally, directories of all nodes under a sector and station under a node are provided in sector and node data files respectively.

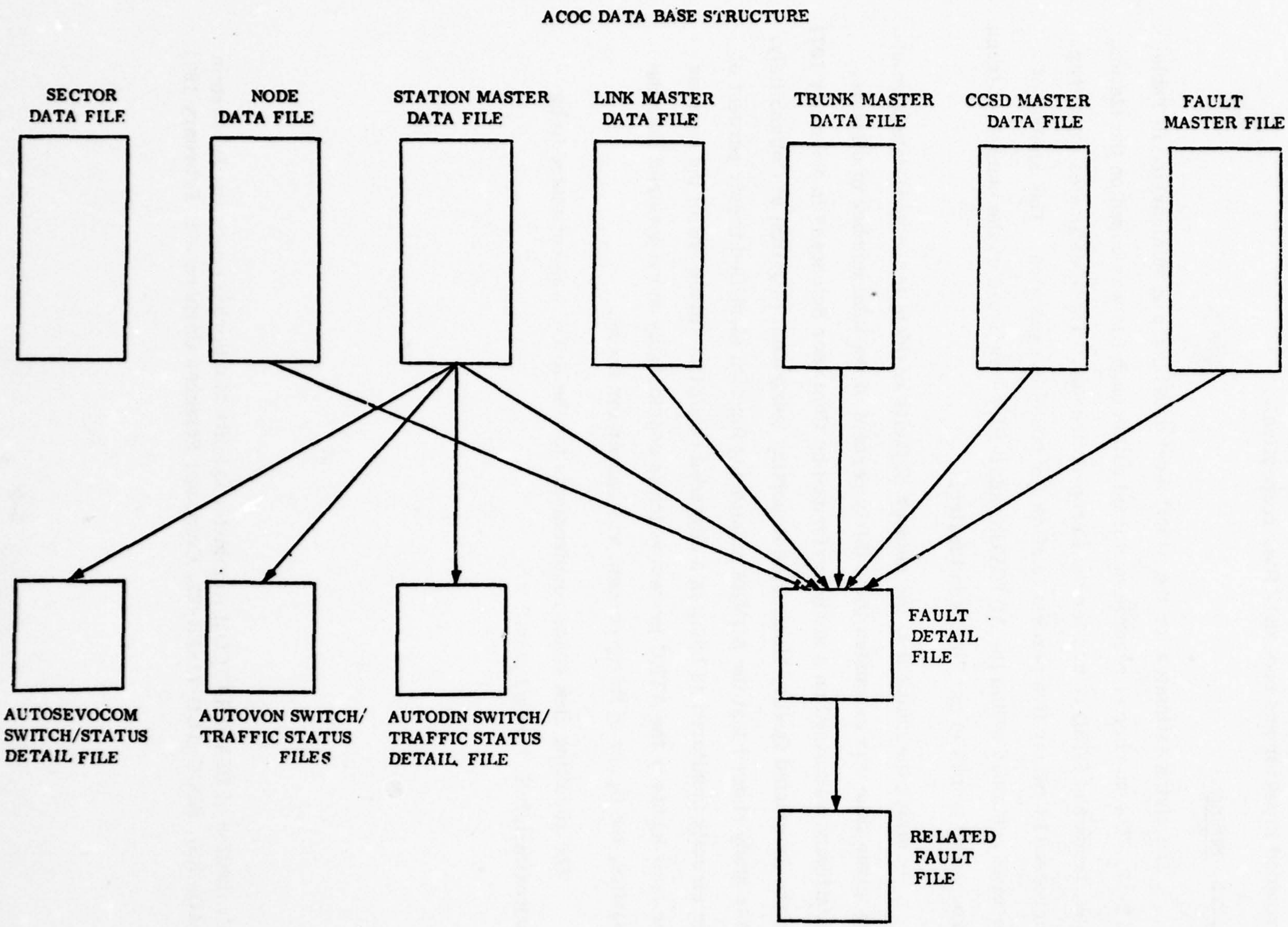
5.2.3 Sizing

The sizing estimates for the ACOC level data base are summarized in Table 5.2-17. The number of records contained within each file was based on the station, link, trunk and CCSD counts for the European theater. These estimates were then increased by twenty five percent to allow for possible expansion. The number of records contained within the AUTOVON detail files was based on the number of trunk groups and trunks in the European theater.

In sizing the fault files, the number of faults resident in the node data base at any given time was estimated to be thirty percent of the total number of circuits. This figure was based on a study performed by Computer Sciences* in February 1971 on the Automated Quality Monitoring Reporting Subsystem (AQMRS) at Coltano Italy. This study showed that the AQMRS monitoring function identified twenty percent of the circuits monitored as being in a degraded condition. Since one of the sources for fault inputs is the ATEC system which is considerably more powerful than the AQMRS, the figure of thirty percent was chosen for sizing.

The resulting disk space requirements for the ACOC was estimated to be approximately 6.7 megabytes.

*Evaluation of USASTRATCOM Automated Quality Monitoring Reporting Subsystem (AQMRS), SCCC-TED-71-FR-22, Computer Sciences Corporation, February 1971.



Note: The arrows indicate pointers within the Data File records allowing access to the detail or subordinate file records.

Figure 5. 2-1. ACOC Data Base Structure

Table 5.2-1. Sector Master Data File

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Sector ID	Code uniquely identifying a given sector.	ASCII	1
Node List	List of all nodes responsible to the sector (5 maximum).	ASCII	5
			Total = 6

Table 5.2-2. Node Master Data File

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Node ID	Code uniquely identifying a given node.	ASCII	1
Sector ID	Sector to which the node is responsible.	ASCII	1
Station List	List of all stations responsible to the node (16 maximum).	ASCII	48
Fault Detail Pointer	Pointer to the first record in the Fault Detail Data file that is associated with the given node.	Integer	1
			Total = 51

Table 5.2-3. Station Master Data File

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Station ID	Name uniquely identifying the station. This field consists of a three character site code and a three character type code such as "DIN" for an AUTODIN station or "TCF" for a manual tech control facility.	ASCII	3
Node ID	Node to which the station is responsible.	ASCII	1
Link List	List of all links at the station (16 maximum).	ASCII	48
ATEC Indication	Code indicating whether or not the station is equipped with ATEC monitoring equipment.	ASCII	1
HAZCON/Station Status Indication	Code indicating a HAZCON condition or station status.	ASCII	2
Fault Detail Pointer	Pointer to the first record in the Fault Detail Data File with the given station as the responsible station.	Integer	1
AUTODIN Station Detail Pointer	Pointer to the associated record in the AUTODIN Switch/Traffic Status Detail Data File (if applicable).	Integer	1
AUTOVON Station Detail Pointer	Pointer to the associated record in the AUTOVON Switch/Traffic Status Detail Data File (if applicable).	Integer	1
AUTOSEVOCOM Station Detail Pointer	Pointer to the associated record in the AUTOSEVOCOM Switch Status Detail File (if applicable).	Integer	1
			TOTAL = 59

Table 5.2-4. Link Master Data File

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Link ID	Link Number	ASCII	3
Responsible Stations	Terminating stations for directions 1 and 2 of a given link.	ASCII	6
Trunk List	List of all DCS trunks on a given link (26 maximum).	ASCII	78
DOD (Direction 1)	Code indicating the degree of degradation in Direction 1 of the link.	ASCII	2
Isolation Flag (Direction 1)	Code indicating whether or not a fault in Direction 1 has been isolated.	ASCII	1
Fault ID (Direction 1)	Fault number assigned to a fault in Direction 1 of the link. Refer to the description of the Fault ID in the Fault Master Data File for the format of this field.	ASCII	3
DOD (Direction 2)	Code indicating the degree of degradation in Direction 2 of the link.	ASCII	2
Isolation Flag (Direction 2)	Code indicating whether or not a fault in Direction 2 has been isolated.	ASCII	1
Fault ID	Fault number assigned to a fault in direction 2 of the link. Refer to the description of the Fault ID in the Fault Master Data File for the format of this element.	ASCII	3
Fault Detail Pointer	Pointer to the first record in the Fault Detail Data File that is associated with the given link number.	Integer	1
			TOTAL = 100

Table 5.2-5. Trunk Master Data File (Sheet 1 of 2)

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Trunk ID	Trunk Number	ASCII	3
Responsible Stations	Terminating stations for directions 1 and 2 of a given trunk.	ASCII	6
VFCT CCSD	CCSD number (for VFCT trunks only).	ASCII	4
CCSD List	List of all CCSD's on a given trunk (32 maximum)	ASCII	128
Connectivity	Trunk connectivity list consisting of the nodes, stations, links, supergroups and groups that the trunk is routed over. The list will also indicate how the trunk appears at each station, i.e., VF termination, thru group, IF repeater, etc. In the example below, a trunk begins at LKF (node 01) manual tech control facility is thru-grouped at DON (node 2) and terminates at PMS. Node Type Direction Station Link SG G 01 V T LKFTCF M0671 02 3 02 G T DONTCF M0724 04 5 02 V R PMSTCF 00000 00 0	ASCII	180
Reroute ID (Preplanned)	Preplanned reroute trunk number. When alt-routing a trunk, the new connectivity can be found in the Trunk Master record for the trunk listed in this field.	ASCII	3
Reroute ID (Unplanned)	Rerouted trunk ID for those alt-routes employing a trunk other than the preplanned trunk. The new connectivity can be found in the Trunk Master record for the trunk listed in this field.	ASCII	3
Reroute Flag	Indication that the given trunk has been alt-routed.	ASCII	1

Table 5.2-5. Trunk Master Data File (Sheet 2 of 2)

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
DOD (Direction 1)	Code indicating the degree of degradation in Direction 1 of the trunk.	ASCII	2
Isolation Flag (Direction 1)	Code indicating whether or not a fault in Direction 1 has been isolated.	ASCII	1
Fault ID (Direction 1)	Fault number assigned to a fault in Direction 1 of the trunk. Refer to the description of the Fault ID in the Fault Master Data File for the format of this field.	ASCII	3
DOD (Direction 2)	Code indicating the degree of degradation in Direction 2 of the trunk.	ASCII	2
Isolation Flag (Direction 2)	Code indicating whether or not a fault in Direction 2 has been isolated.	ASCII	1
Fault ID (Direction 2)	Fault number assigned to a fault in Direction 2 of the trunk. Refer to the description of the Fault ID in the Fault Master Data File for the format of this field.	ASCII	3
Fault Detail Pointer	Pointer to the first record in the Fault Detail Data File that is associated with the given trunk number.	Integer	1
			TOTAL = 341

Table 5.2-6. CCSD Master Data File (Sheet 1 of 2)

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
CCSD Number	Circuit Number	ASCII	4
Restoration Priority	Restoration priority of the given circuit.	ASCII	2
CCSD Type	Code indicating the traffic type on the circuit, i.e., VON IST, DIN IST, etc.	ASCII	2
VFCT Trunk Number	VFCT Trunk associated with the circuit (for VFCT CCSD's only)	ASCII	3
Connectivity	Circuit connectivity list consisting of the trunk and channel numbers over which the circuit is routed. In the example below, a circuit is routed over two trunks using Channel 10 of the first and channel 2 of the second. 44JMB1/10, 45CMA2/02	ASCII	150
Reroute ID (Preplanned)	Preplanned reroute circuit number. When alt-routing a circuit, the new connectivity can be found in the CCSD master record for the circuit listed in this field.	ASCII	4
Reroute ID (Unplanned)	Rerouted CCSD number for those alt-routes employing a CCSD other than the preplanned CCSD. The new connectivity can be found in the CCSD Master Record for the circuit listed in this field.	ASCII	4
Reroute Flag	Indication that the given circuit has been alt-routed.	ASCII	1
DOD (Direction 1)	Code indicating the degree of degradation in Direction 1 of the circuit.	ASCII	2

Table 5.2-6. CCSD Master Data File (Sheet 2 of 2)

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Isolation Flag (Direction 1)	Code indicating whether or not a fault in direction 1 has been isolated.	ASCII	1
Fault ID (Direction 1)	Fault number assigned to a fault in direction 1 of the circuit. Refer to the description of the Fault ID in the Fault Master Data File for the format of this field.	ASCII	3
DOD (Direction 2)	Code indicating the degree of degradation in Direction 2 of the circuit.	ASCII	2
Isolation Flag (Direction 2)	Code indicating whether or not a fault in Direction 2 has been isolated.	ASCII	1
Fault ID (Direction 2)	Fault number assigned to a fault in Direction 2 of the circuit. Refer to the description of the Fault ID in the Fault Master Data File for the format of this field.	ASCII	3
Fault Detail Pointer	Pointer to the first record in the Fault Detail Data File that is associated with the given circuit number.	Integer	1
			TOTAL = 183

Table 5.2-7. Fault Master Data File

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Fault ID	Code uniquely identifying each fault reported within the system. The first two characters of this field will consist of the Node ID to which the problem was first reported. The last four characters will be the the next number in a sequential list of unassigned numbers.	ASCII	3
Link, Trunk or CCSD Number	The link, trunk or circuit on which the fault was reported.	ASCII	4
Fault Detail Pointer	Pointer to the record in the Fault Detail Data File that is associated with the given fault.	Integer	1
			TOTAL = 8

Table 5.2-8. Fault Detail Data File (Sheet 1 of 3)

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Fault ID	Fault number assigned to the trouble report initially entered on a link, trunk or circuit. This number will be the same as that contained in the Fault Master Data record.	ASCII	3
Reporting Station	Station where the initial link, trunk, or circuit trouble report was entered into the system.	ASCII	3
Fault Severity	Code indicating the type of fault, i.e., link, trunk or circuit.	ASCII	1
DTG of Report	Date-time group when the trouble report was generated.	ASCII	4
Link, Trunk or CCSD	The link, trunk or circuit number associated with the specified trouble report.	ASCII	4
Direction	Direction on which the fault was reported.	ASCII	1
RFO	Code indicating the reason for outage.	ASCII	2
ETR	Estimated time to repair the problem.	ASCII	4
In/Out Station	Code indicating whether the reporting station is actually reporting for another station.	ASCII	1
Pre-emption Flag	Flag indicating that fault isolation was stopped on this fault because it may have been caused by some higher order fault.	ASCII	1
DOD	Code indicating the degree of degradation reported on the link, trunk or CCSD.	ASCII	2
Isolation Flag	Code indicating whether or not the fault has been isolated.	ASCII	1

Table 5.2-8. Fault Detail Data File (Sheet 2 of 3)

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Alt-Route Flag	Code indicating whether or not the trunk or CCSD with the reported fault has been alt-routed.	ASCII	1
DTG of Alt-Route/ Restoral	Data-time group that the trunk or circuit was alt-routed and service restored to the user.	ASCII	4
DTG of Repair	Date-time group the problem was repaired and the fault closed.	ASCII	4
Responsible Station	Station responsible for closing the fault. This station is determined to be the terminating station for a given direction of a link, trunk, or circuit.	ASCII	3
Restoration Priority	Restoration priority of the circuit associated with the fault (if applicable).	ASCII	1
Remarks	Comments made by the operator when entering the trouble report.	ASCII	40
Related Fault Pointer	Pointer to the first record in the related fault file that is associated with the given fault ID.	Integer	1
Fault Detail Pointer	Pointer to the next record in the Fault Detail Data file that is associated with the given link number (if applicable).	Integer	1
Fault Detail Pointer	Pointer to the next record in the Fault detail data file that is associated with the given trunk number (if applicable).	Integer	1
Fault Detail Pointer	Pointer to the next record in the Fault Detail Data file that is associated with the given circuit number (if applicable).	Integer	1

Table 5.2-8. Fault Detail Data File (Sheet 3 of 3)

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Fault Detail Pointer	Pointer of the next record in the Fault Detail Data file that contains a pre-empted lower order fault.	Integer	1
Fault Detail Pointer	Pointer to the next record in the Fault Detail Data file that is associated with the given responsible station.	Integer	1
Fault Detail Pointer	Pointer to the next record in the Fault Detail Data file that is associated with the given node.	Integer	1
			TOTAL = 87

Table 5.2-9. Related Fault File

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Fault ID	Fault ID assigned to a trouble report on a given link, trunk or circuit. Should more than one report be sent to the node, they will be assigned the same Fault ID as the original report and stored in the Related Fault Detail Data File.	ASCII	3
Link, Trunk or CCSD	Link, trunk or circuit associated with the given fault.	ASCII	4
DTG of Report	Date-time group of trouble report.	ASCII	4
Reporting Station	Station reporting the fault.	ASCII	3
Related Fault Pointer	Pointer to the next record in the Related Fault File that is associated with the same Fault ID.	Integer	1
			TOTAL = 15

Table 5.2-10. AUTODIN Switch/Traffic Status Detail Data File

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Switch Hardware Status	Code indicating an equipment outage at the switch. The field is large enough to contain 20 such reports. The first 6 characters will contain the equipment code* while the last 6 will contain the Fault ID. The reason for outage code, date-time group of the outage, and the time of repair will be stored in a detailed fault record.	ASCII	120
System Status	The system status report generated by the switch will be stored in this field. The data includes a system line, 228 channel lines, a message line, load line, IC/OV line and tape function lines.**	ASCII	1859
	* Equipment codes can be found in DCA 310-55-1, Section 8. ** Refer to DCAC 310-D70-30 for line formats.		Total = 1,979

Table 5.2-11. AUTOVON Switch Status File (Sheet 1 of 2)

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Switch Call Processing Efficiency	Switch I.D., call processing efficiency percentage, file type and the time the efficiency figure was reported.	BCD	2
Register Junctor Call Processing Efficiency	Call processing efficiency of a registor junctor of the AUTOVON Switch identified with the switch call processing efficiency and the time it was reported.	BCD	48
Pool Equipment Status	Codes indicating the service busy and maintenance busy status of Register Junctors, TCMF Receivers, and MF 2/6 Transceivers and the time the status was reported.	Binary	8
Switch Equipment Status	Codes indicating the out of service status of Logics, Memories, Markers, System Stop Clock, and Comparator Manual Mode and the time the status was reported.	Binary	2
Register Junctor Maintenance Busy Summary	Total and percentage of Register Junctors maintenance Busy and Time the summary was reported.	BCD	3
TCMF Receiver Maintenance Busy Summary	Total and percentage of TCMF Receivers maintenance Busy and time the summary was reported.	BCD	3
MF 2/6 Transceiver Maintenance Busy Status Summary	Total and percentage of MF 2/6 Transceivers Maintenance Busy and time the summary was reported.	BCD	3
TCMF Receiver Overload Indicator	An indicator of the number of busy TCMF Receivers exceeding a threshold and time the threshold was exceeded.	BCD	1

Table 5.2-11. AUTOVON Switch Status File (Sheet 2 of 2)

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
ATOP	An indicator of Automatic Traffic Overload protection being in effect and the time it went into effect.	BCD	1
Line Load Control	An indicator that a Line Load Control has been manually imposed and the time the control was imposed.	BCD	3
ARB	An indicator that all Register Junctors of the reporting switch are busy and the time they became busy.	BCD	1
Incorrect ATOP Setting	An indicator that the ATOP Switch Setting of the reporting switch is equal to or greater than the number of Register Junctors installed.	BCD	1
Routing Table	Area Routing Table	ASCII	600
			Total = 677

Table 5.2-12. AUTOVON Trunk Group Status File

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Trunk Group Identifier	Switch identifier, an indicator of type trunk group, Connecting switch or PBX identifier, file type, and trunk group identifier.	Binary Encoded and BCD	2
Busy Idle Summary	Total number of calls in progress at each precedence and the time the report was made.	BCD	3
ATB	An indicator that all trunks in the trunk group are busy and the time the status was reported.	BCD	1
Immediate Higher Precedence Blockage (Tandem)	Originating trunk identity, and the time the blockage recurred.	BCD	2
			Total = 8

Table 5.2-13. AUTOVON Trunk Information File

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Trunk Identifier	Switch identifier, and indicator of type trunk, connecting switch or PBX identifier, file type, and trunk identifier.	Binary Encoded and BCD	2
Trunk Trouble Report	Total troubles reported on this trunk, indicator of type trouble, and trouble report times.	BCD	20
Originating Immediate or Higher Precedence Blockage	NNX/NYX Code Blocked, Terminating Trunk Group/ Trunk and Report Time	BCD	3
Busy/Idle Status	Busy/Idle indicator of trunk and the time it was reported	Hexidecimal	2
CCSD	Trunk CCSD	BCD	2
			Total = 29

Table 5.2-14. Dial Code (NNX/NYX) File

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
NNX/NYX Code Identifier	Terminating AUTOVON Switch identifier, an indicator of type trunk, connecting switch or PBX identifier, file type and NNX/NYX Code identifier.	Binary Encoded and BCD	2
Terminating Trunk	Identifier of a terminating four wire line circuit associated directly with the reported NNX/NYX code.	BCD	1
ATPC Code Storage	An indicator that ATPC Code 1 or 2 has been ordered for the NNX/NYX code identified above, the switch codes in which it has been stored, and the time it was stored.	BCD	8
ATPC Code Access Indicator	An indicator that ATPC Code #2 is in use at an AUTOVON switch for the above identified NNX/NYX Code, the time accessed, and the switch at which it was in use.	BCD	2
			Total = 13

Table 5.2-15. AUTOVON Switch/PBX Congestion Report File

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Connecting PBX Switch Identifier	Switch Code, Connecting Switch or PBX Identifier, and File identifier.	BCD	1
First Tandem Switch Overload	NNX/NYX Code reported, and the time report was made.	BCD	2
Excessive Calls Alternate Routed to Connecting Switch	NNX/NYX Codes and time the excessive alternate routed calls message was generated.	BCD	13
Excessive Calls from Connecting Switch	An indicator of an incoming overload from the connecting switch, and the time reported.	BCD	1
Immediate or Higher Precedence Blockage to PBX	Blockage indicator and time blockage occurred.	BCD	1
			Total = 18

Table 5.2-16. AUTOSEVOCOM Switch Detail Data File

ITEM	DESCRIPTION	FORMAT	SIZE (WORDS)
Switch Hardware Status	Code indicating an equipment outage at the switch. The field is large enough to contain 20 such reports. The first 6 characters will contain the equipment code* while the last 6 will contain the Fault ID. The reason for outage code, date-time group of the outage, and the time of repair will be stored in a detailed fault record.	ASCII	120
	* Equipment codes can be found in DCA 310-55-1, Section 7.		Total = 120

Table 5.2-17. ACOC Level Data Base Sizing

DATA FILE NAME	RECORD SIZE (WORDS)	NUMBER OF RECORDS	FILE SIZE WORDS	FILE SIZE BYTES
SECTOR MASTER	6	4	24	48
NODE MASTER	51	20	1,020	2,040
STATION MASTER	59	300	17,700	35,400
LINK MASTER	100	410	41,000	82,000
TRUNK MASTER	341	1,250	426,250	852,500
CCSD MASTER	183	12,500	2,287,500	4,595,000
FAULT MASTER	8	3,600	28,800	57,600
FAULT DETAIL	87	3,600	313,200	626,400
RELATED FAULT DETAIL	15	3,600	54,000	108,000
AUTODIN SWITCH/TRAFFIC STATUS DETAIL	1,979	10	19,790	39,580
AUTOVON SWITCH STATUS DETAIL	677	15	10,155	20,310
AUTOVON TRUNK GROUP STATUS DETAIL	8	1,000	8,000	16,000
AUTOVON TRUNK INFORMATION DETAIL	29	4,000	116,000	232,000
DIAL CODE NNX/NYX DETAIL	13	800	10,400	20,800
AUTOVON SWITCH/PBX CONGESTION REPORT DETAIL	18	74	1,332	2,664
AUTOSEVOCOM SWITCH STATUS DETAIL	120	20	2,400	4,800
TOTAL			3,346,571	6,693,142

5.3 SOFTWARE CONSIDERATIONS FOR THE ACOC

A preliminary software design for the ACOC has been performed using the THREADS design methodology. This process is described in detail in Section 1.4. In the following subsections a detailed software design for the ACOC level of Unified Control is presented in terms of the THREADS (identified during the design effort) to support the functional capabilities discussed in Section 5.1.

For each ACOC function a THREAD flow diagram which describes the processing steps required in accomplishing the function and the routines supporting each processing step is presented. A sizing analysis is then provided which addresses individual routine size requirements as well as overall ACOC processing system size requirements including estimates of lines of code and memory occupancy. Processor memory requirements are then addressed including support software, resident data structures and overlay techniques. A parametric processing load analysis is provided which shows processor and disk load requirements for the ACOC as a function of various system event occurrence rates. Finally, the general characteristics of processor support software as they pertain to the ACOC level of unified control are discussed.

5.3.1 ACOC Software Design

The following paragraphs present a software system design for the ACOC in terms of 54 ACOC level THREADS. These THREADS are derived from the ACOC level requirements presented in Section 5.1, where each THREAD supports a specific functional requirement. The THREADS are first presented in a hierarchical structure which shows all software capabilities available to each functional element of unified control at the ACOC level. Each THREAD is additionally described in a THREAD flow diagram which shows the discrete processing requirements and individual routines necessary to accomplish the prescribed functional. Finally, all routines identified in the THREAD flow diagrams are summarized in a hierarchical computer program structure showing the various levels of control within the applications software system.

5.3.1.1 ACOC THREADS

Figure 5.3-1 summarizes the THREADS which comprise the ACOC level of unified control. The figure shows a two-level hierarchy of THREADS supporting each operational element serviced by the ACOC including the ACOC Controller, Sectors, other ACOCs, and the SATCOM Controller.

The top level of the hierarchy performs I/O and preliminary message processing functions. The software represented by these THREADS performs line handling, buffer management, and task scheduling activities. The stimulus to these THREADS is generally an interrupt or other condition indicating a call for input or output service, while the response is a completed I/O operation with appropriate subsequent processing scheduled. Each subsequent processing task is supported by a distinct THREAD located on the second level of the hierarchy. The scheduling activities performed by the top level THREADS serve as the stimuli to the various second level THREADS.

The second level THREADS are grouped into five subtrees corresponding to the five sources of external stimulus to the ACOC. These groups are mapped to the top level THREAD they support by the connectors K through O on the first sheet of the figure. To examine the support available to a given ACOC element it is necessary only to inspect the corresponding subtree for that element.

The THREADS contained in Figure 5.3-1 are presented in an abbreviated format. In the next paragraph each THREAD will be expanded into a flow diagram in order to show the detailed processing requirements and associated software requirements to accomplish the function supported by the THREAD.

5.3.1.2 THREAD Flow Diagrams

Figures 5.3-3 through 5.3-8 show the detailed flow diagrams for the ACOC level THREADS. Each figure contains the diagrams for all THREADS which support a given ACOC element. Table 5.3-1 summarizes the contents of these figures.

The basic format of the flow diagram is shown in Figure 5.3-2. The stimulus and response information will be the same as indicated in the abbreviated formats used in the THREAD hierarchy. However, while the processing information is summarized in the abbreviated format, it is expanded into a series of more precise steps in the flow diagram. Each step also lists the computer programs necessary to support the indicated processing.

The supervisory level and I/O diagrams are shown in Figure 5.3-3. These THREADS divide into two basic types. The first five THREADS address input processing of data from each unified control element which communicates directly with the ACOC. In addition to input handling functions they perform supervisory schedulingfunctions based on the message types that are received. The remaining three THREADS perform communications output handling for the Sector, ACOC, and Journal device interfaces.

Figure 5.3-4 shows the THREAD diagrams which process messages received from the Sector. The majority of the messages received from the Sector are of three general types: responses to requests for data from the Node and Sector levels, requests to supply data to the Node and Sector levels, and fault related broadcast messages.

Messages are also passed over this interface containing switch equipment status from the switched networks. Additionally, AUTOVON traffic related information is forwarded through the system and is received from the Sector. Upon receipt of this traffic data, the network-wide correlation processing function is performed to determine switch related problems. This correlation process is discussed in detail in Section 6 of this report.

Figure 5.3-5 shows the ACOC handling software. The message types received from other ACOCs are similar to the messages received from the Sectors. Control directive messages are supported in both directions on this interface.

The ACOC Controller software is shown in Figure 5.3-6. In general, most of the requests made from this position are for retrieval of data base contents, or for

issuing control directives (reroute, connectivity modifications). Both transmission related and switched network related status information is available in the local ACOC data base. A detailed description of traffic display data for AUTOVON is contained in Section 6.

Figure 5.3-7 shows the AUTODIN STATS THREAD Diagrams. This software performs thresholding on various queue lengths reported in the summary message, and performs journaling of these reports for reference purposes.

Figure 5.3-8 shows the SATCOM Controller THREAD Diagrams. The capabilities available to this position include fault entry and closure as well as various system status requests. The SATCOM Controller position is operationally similar to a station level controller position.

In the next paragraph, all of the computer programs which are identified in Figures 5.3-3 through 5.3-8 are presented in a computer program hierarchy in order to show the relationships of the various routines and to summarize the applications software system for the ACOC.

5.3.1.3 Computer Program Hierarchy

All of the routines which are identified in the ACOC level THREADS have been structured into a six-level program hierarchy. In determining the appropriate level for a given routine, two guidelines are followed. First, a given routine may call only these routines which reside at lower hierarchical levels. The application of this rule ensures that the levels of the hierarchy indicate the various levels of control within the software system. Second, each level of the hierarchy should be functionally homogeneous. That is, routines which perform similar functions should be grouped at a given hierarchical level.

Figure 5.3-9 shows the program hierarchy for the ACOC level of unified control.

The top level of the hierarchy contains the ACOC SUPERVISOR which controls execution of all scheduled events in the software system.

The second level contains the interrupt driven I/O drivers and a series of message processors. Each message processor controls the support activities for one of the major input sources at the ACOC. In general, these routines supervise message decoding/validation and perform overlay retrieval.

The third level of the hierarchy contains the routines responsible for performing major operational functions. Such functions include processing individual ACOC Controller, SATCOM Controller, Sector, and ACOC message types.

The fourth level provides significant support functions to the various third level routines. For example, the third level ACOC CONNECTIVITY DISPLAY PROCESSOR depends heavily on the four connectivity RETRIEVAL routines on this level. This amount of functional support minimizes duplication of software between the various operational function routines on the third level. In addition, it provides a level of insulation between the functionally oriented routines in the upper levels and the various data base structures employed in the lower levels of the hierarchy.

The fifth level consists largely of file managers for the various components of the data base. These file managers rely heavily on the sixth level generic data base management support routines FIND, GET, CREATE, DELETE and MODIFY for access to the various files. Additional system support activities supplied on the sixth level include error processing, message type decoding and I/O buffer management.

5.3.2 Software Sizing

The following two paragraphs present a software sizing analysis for the ACOC. In the first paragraph, each routine identified during the design effort is addressed in terms of estimated lines of code and program and data occupancy requirements. The second paragraph then presents ACOC processor memory requirements based on a two-level overlay structure.

5.3.2.1 Program Sizing

The sizing of the programs presented in this paragraph is basedon an estimation of the number of lines of HOL code required to implement each routine in the ACOC program hierarchy (Paragraph 5.3.1.3), plus additional memory required to accommodate data for each routine. This sizing includes applications software and operating system enhancements only and assumes that the host computer supplies support software capabilities as described in 5.3.4.

Table 5.3-2 summarizes the program sizing for the Sector. The program occupancy for each routine is based on an expansion factor of 15 bytes of storage for each line of HOL. This ratio is typical of 16-bit word length machines using currently available HOL compilers. Further justification of this expansion ratio is provided in Section 1.4. Where applicable, the data occupancy for each routine includes buffer and table space requirements. Without the use of overlays, the total memory requirement for theACOC applications software is 223K bytes.

5.3.2.2 Processor Memory Requirements

The software system described in Section 5.3.1 is functionally partitionable and is susceptible to incorporation into an overlay structure. The use of overlays, where on-line secondary storage capabilities are available, minimizes processor memory requirements by retaining low demand software in secondary storage.

An overlay structure for the ACOC software was developed by dividing the routines contained in the ACOC program hierarchy into three categories: resident, element support and functional support.

The resident routines are high demand routines which support supervisor/control of all processing functions. Such routines as the ACOC SUPERVISOR, and the I/O drivers are considered in this category since they are used to support high demand system functions. Table 5.3-3 summarizes the resident routines for the ACOC. These routines require 15,785 bytes of memory.

The routines which compose the support overlays are also summarized in Table 5.3-3 according to the operational element which they support. The elements and their respective support sizes are summarized below:

ACOC Controller Support	71,925 bytes
Sector Support	71,625 bytes
ACOC Support	67,500 bytes
DIN STATS	9,375 bytes
SATCOM	96,300 bytes

The routines which are used for supporting an operational element are defined to be those routines that would be needed by any of the functional routines supporting the given element.

The routines comprising the functional overlays for the ACOC Controller, Sector, ACOC, DIN STATS, and SATCOM are summarized in Table 5.3-4. Depending on the function to be performed, only one of these overlays would be in memory at any time.

In order to determine the amount of memory required at the ACOC for applications software, it is necessary to add the memory requirements for the resident routines, support overlay routines and the largest functional overlay module for each ACOC element. Table 5.3-5 shows that the largest memory requirement occurs for processing Sector input. In this case the applications software requires 114,410 bytes of main memory.

In addition to the applications software requirements, the processor memory must accommodate the resident portion of a disk-based operating system. Based upon currently available real-time operating system software, a residency requirement for an operating system providing the support outlined in Section 5.3.4 is 12,000 bytes. This does not include occupancy within the operating system for the I/O drivers and buffer areas which were sized as part of the applications software. The total ACOC memory requirement is now determined to be 126K bytes.

5.3.3 ACOC Processing Load

A worst case sustained load analysis for the ACOC is presented in this paragraph. Both processor and disk utilizations are considered because of the large amount of data base access activity required to support unified control functions. The utilizations are parametrically derived and presented in a series of curves which show utilization as a function of the rate of Sector and ACOC fault notification, SATCOM fault entry, and DIN STATS Summary Message receipt.

Table 5.3-6 summarizes the set of worst case algorithms on which the ACOC load analysis is based. Each algorithm is analyzed for the number of assembly language instructions executed and the number of disk accesses performed for single execution of the algorithm. The flowcharts and detailed analysis of these algoruthms are contained in Appendix A to this report.

Algorithms A1 and A2 perform fault notification broadcast processing for messages received from the Sectors and other ACOCs respectively. Algorithm A3 performs input processing and thresholding of AUTODIN STATS switch summary messages. Algorithm A4 accepts fault reports initiated by the SATCOM Controller. Algorithm A5 is the worst case display request that can be made from theACOC Controller position. This algorithm will be used later in this paragraph to establish average and worst case operator response times.

Table 5.3-7 shows the derivation of the worst case I/O support load. For each element interfaced at the ACOC the maximum aggregate bandwidth is computed in terms of the number of assembly level instructions required per second to effect the I/O transfers. For the worst case it is assumed that data will be passed a character at a time on the processor I/O bus. From this table the I/O load at the ACOC is 16,290 instructions/sec.

Figure 5.3-10 presents the derivation of the processing load at the ACOC.

From Equation (1) it is seen that the total processing load is the sum of the loads supporting Sector (P_{SECTOR}), and ACOC (P_{ACOC}) fault notifications, STATS

summary message processing (P_{STATS}), SATCOM Controller fault entry processing (P_{SATCOM}), cycle stealing due to disk DMA operation (P_{DISK}), and communications I/O ($P_{I/O}$). Equation (2) shows that the Sector, ACOC, STATS, and SATCOM processing loads are the products of a single occurrence loads and event occurrence rates. Equations (3) through (6) show that the computation of the single occurrence loads for the Sector, ACOC, STATS, and SATCOM Controller respectively. Since the sustained load will be computed for a one minute interval, a time conversion factor is included in these equations to find the average second load. Equation (7) accounts for memory cycle stealing due to the disk DMA activity. An average disk access size of one 256 work block is assumed. Equation (8) shows the communications I/O load. The worst case I/O load as presented in Table 5.3-7 is assumed. By rewriting Equation (2), Equation (9) now shows the ACOC processing load as a function of the rate of message receipt from the other system elements. This equation is plotted in Figure 5.3-11 for values of R_{SECTOR} from 0 to 300, and R_{ACOC} from 0 to 20. On the first sheet of the figure the SATCOM Controller and STATS interfaces are assumed to be idle. On the second sheet, the load including the worst case demands from these elements is plotted. Because of the low bandwidth of sustained activity the average load over the worst case minute is small.

Figure 5.3-12 shows the derivation of the disk load at the ACOC. Equation (1) shows that the total disk load is the sum of the disk loads supporting the various ACOC elements. These quantities are a function of the rate of fault related event occurrence as shown in Equation (2). Equation (7) shows the total disk load as a function of these occurrence rates. Figure 5.3-13 plots D_A as a function of the same variables and ranges used in Figure 5.3-11 for P_A. The 100 percent utilization line for a typical moving head disk with sufficient capacity to accommodate the ACOC data base is also indicated on this figure. The utilization threshold is based on a 50 millisecond average access time.

Extending the worst case example described in Paragraph 4.3.3 the rate of fault notification message receipt from the Sector (R_{SECTOR}) becomes 225 faults/min

(5 Sectors @ 45 messages/Sector). Assuming that three DIN STATS messages arrive during this period, slightly more than 10 notification messages can be processed from other ACOCs before disk saturation occurs. The functional processing load for this saturating condition is seen from Figure 5.3-11 to be about 26,000 instructions/sec. This constitutes a small average second load during the worst case minute.

The worst case is an extreme example since the average fault occurrence rate is projected to be only about 2,000 faults/day assuming the presence of automated monitoring equipment.

Algorithm A5 can be used to determine operator response times as a functionof the relative load on the ACOC processor and disk. The algorithm requires that 18,012 instructions and 16 disk accesses be performed. The response time will be dominated by disk access time. The disk activity, assuming no contention for disk resources would require 800 milliseconds (16 accesses @ 50 milliseconds/access).

Assuming a relatively slow processing capability (8 microsecond average instruction time) the processing would require 144 milliseconds (no contention).

The total time until the connectivity request processing is completed and the data is ready for display is then .944 seconds when no other activity is ongoing.

Assuming that the ACOC is processing 225 Sector level, 10 ACOC level fault notifications, and the worst case SATCOM and STATS messages the response time for this request then degrades to 2.10 seconds (1.75 seconds total for disk, .352 seconds for processing).

5.3.4 Support Software

The operational and development software capabilities required to support ACOC processing functions are similar to the capabilities described for the Node and Sector. This similarity is due to the high degree of functional commonality between all levels of unified control. For a description of the support software requirements see Section 3.3.4.

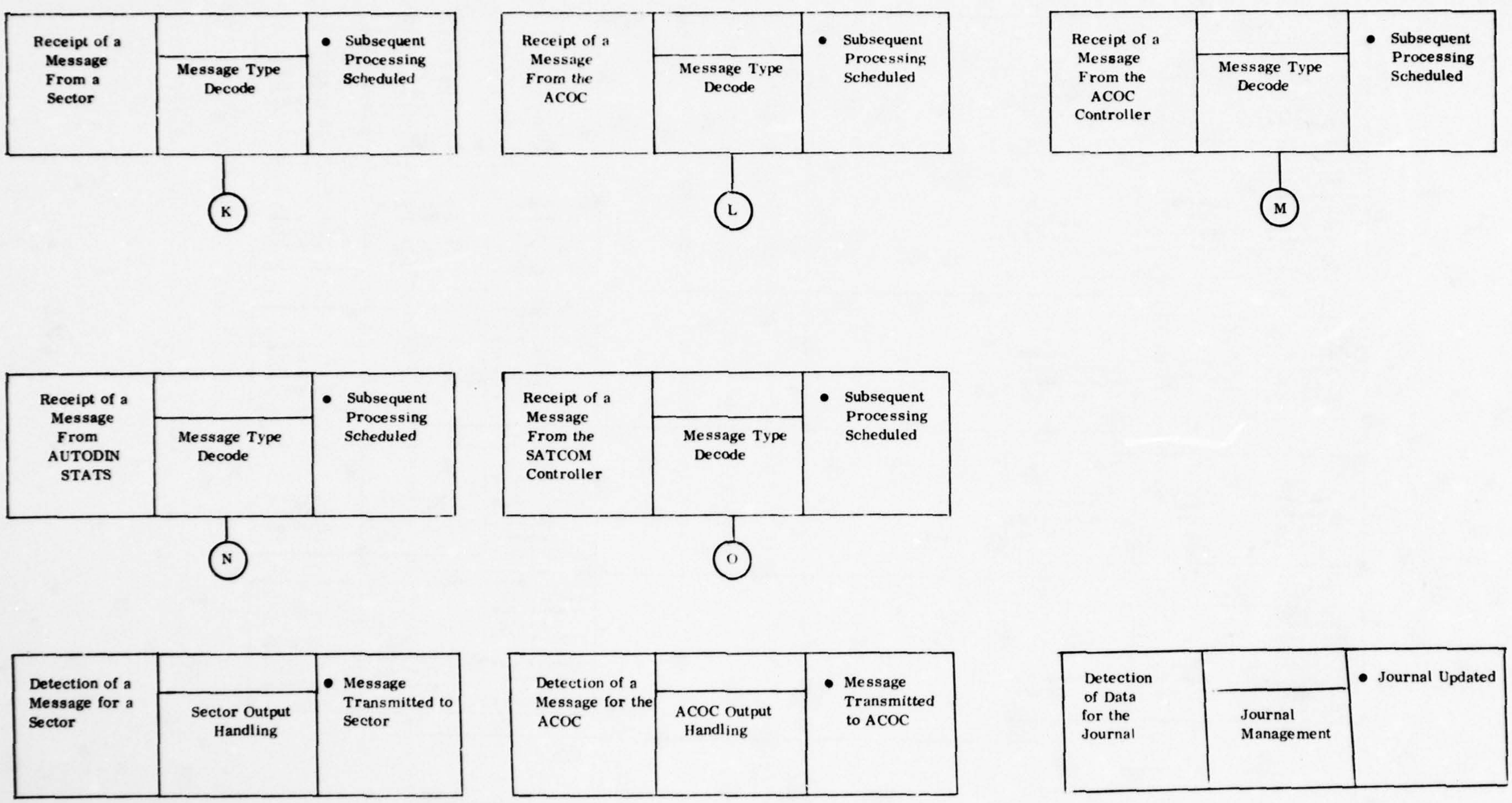


Figure 5.3-1. ACOC Threads (Sheet 1 of 6)

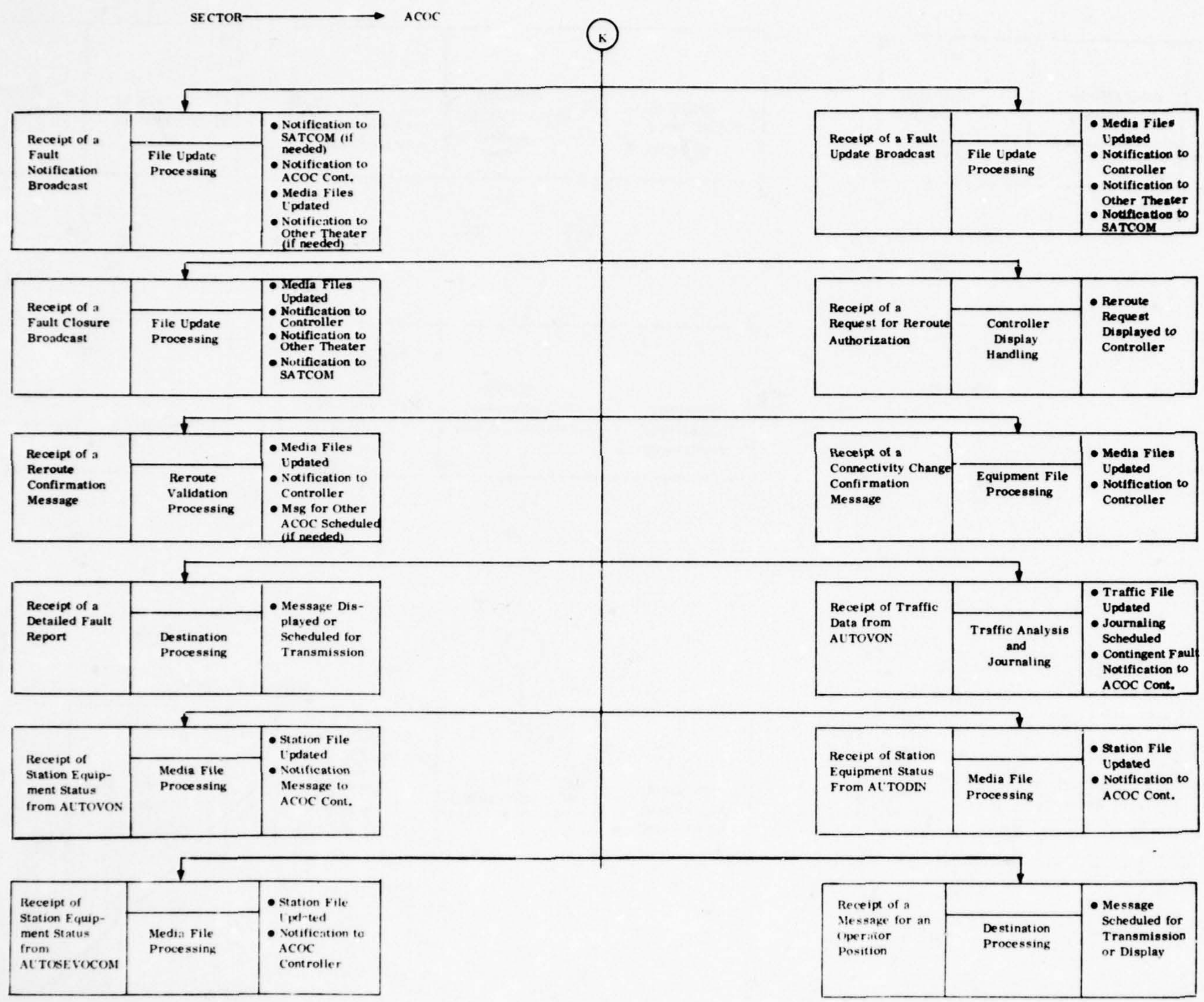


Figure 5.3-1. ACOC Threads (Sheet 2 of 6)

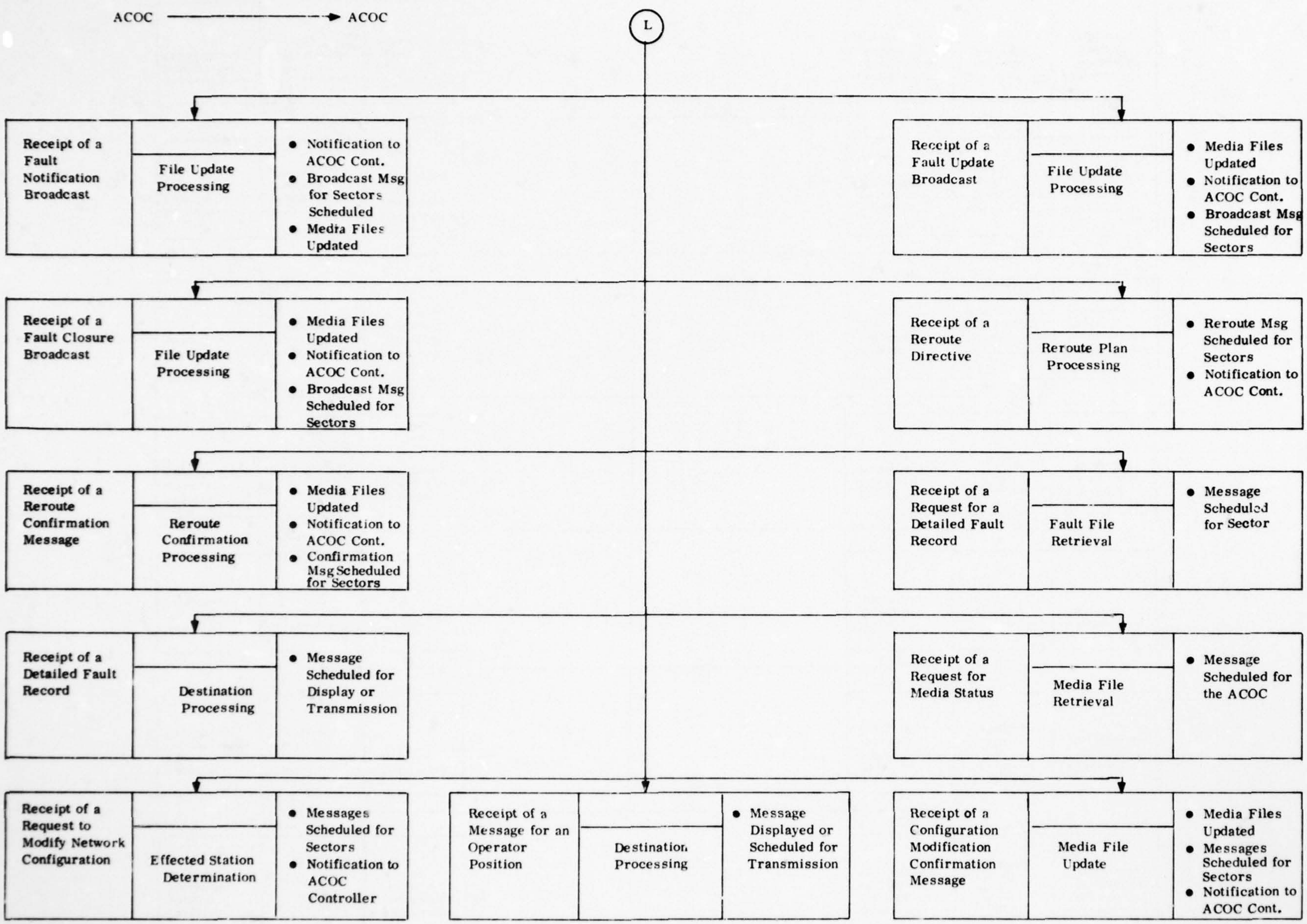


Figure 5.3-1. ACOC Threads (Sheet 3 of 6)

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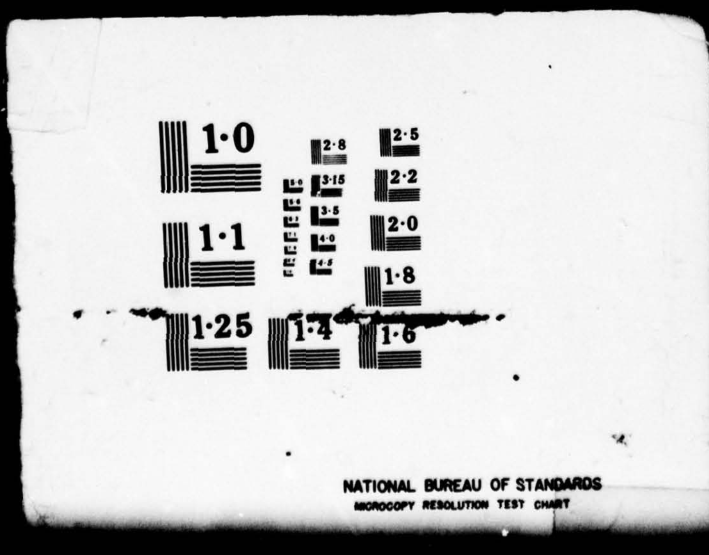


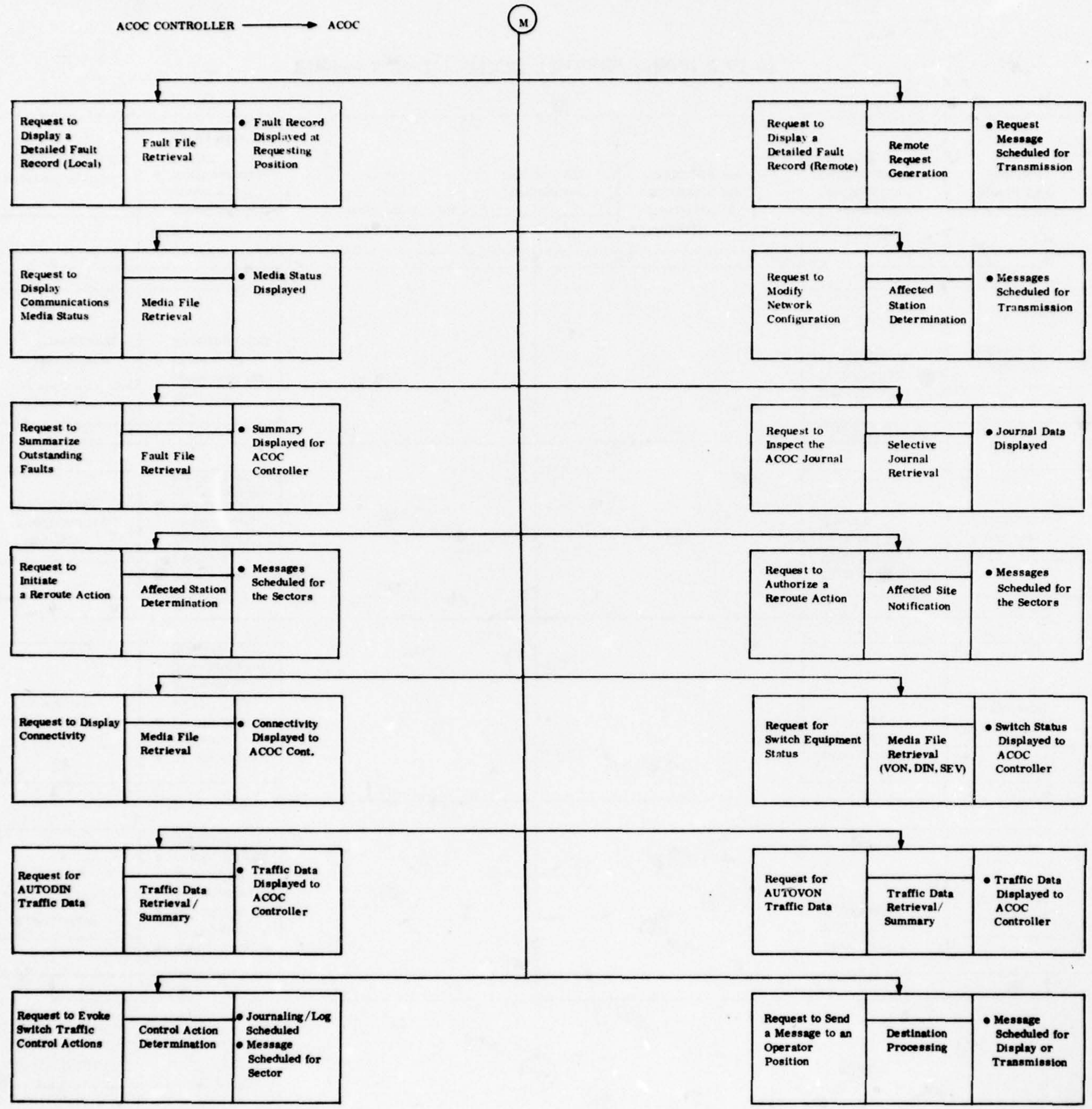


Figure 5.3-1. ACOC Threads (Sheet 4 of 6)

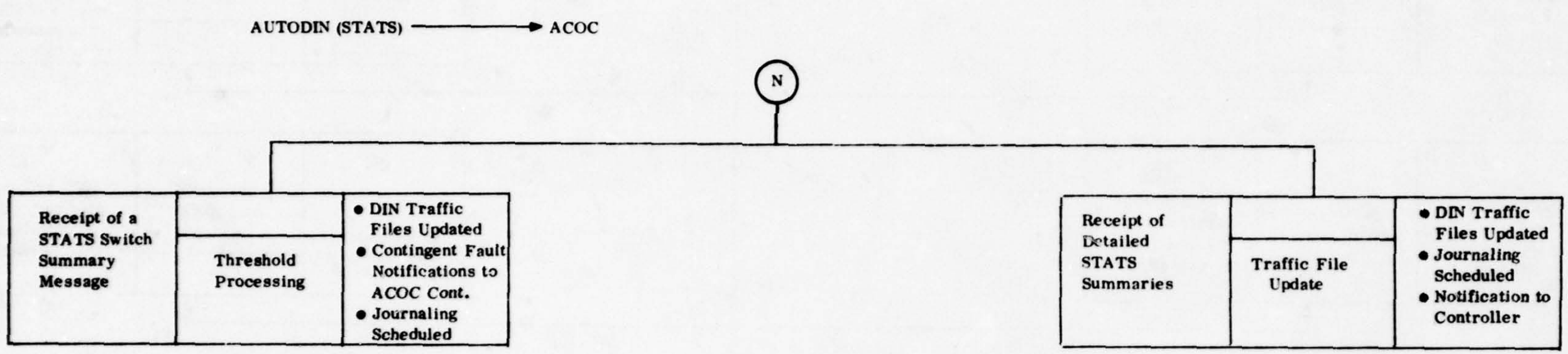


Figure 5.3-1. ACOC Threads (Sheet 5 of 6)

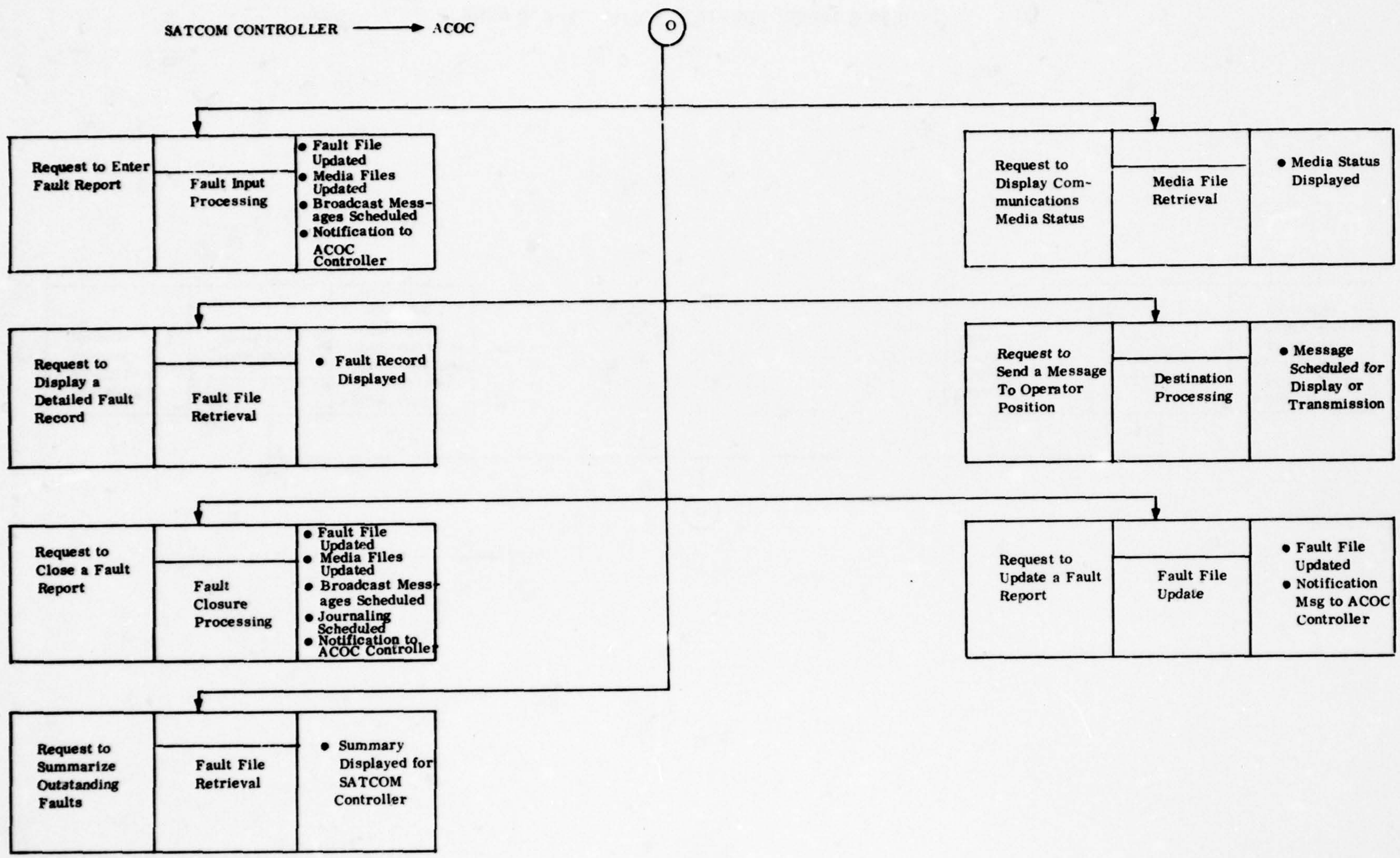


Figure 5.3-1. ACOC Threads (Sheet 6 of 6)

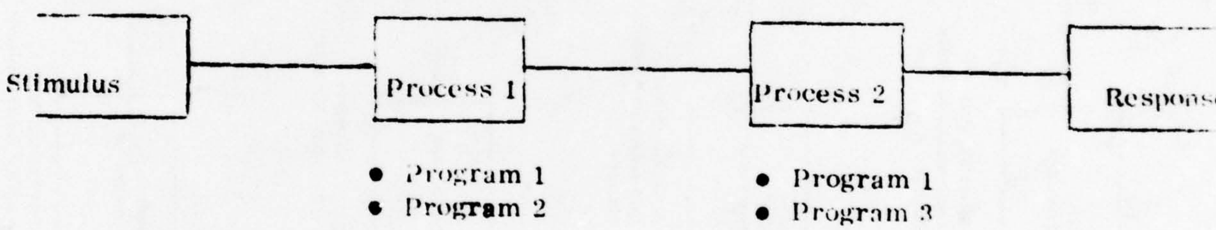


Figure 5.3-2. Format of a THREAD Flow Diagram

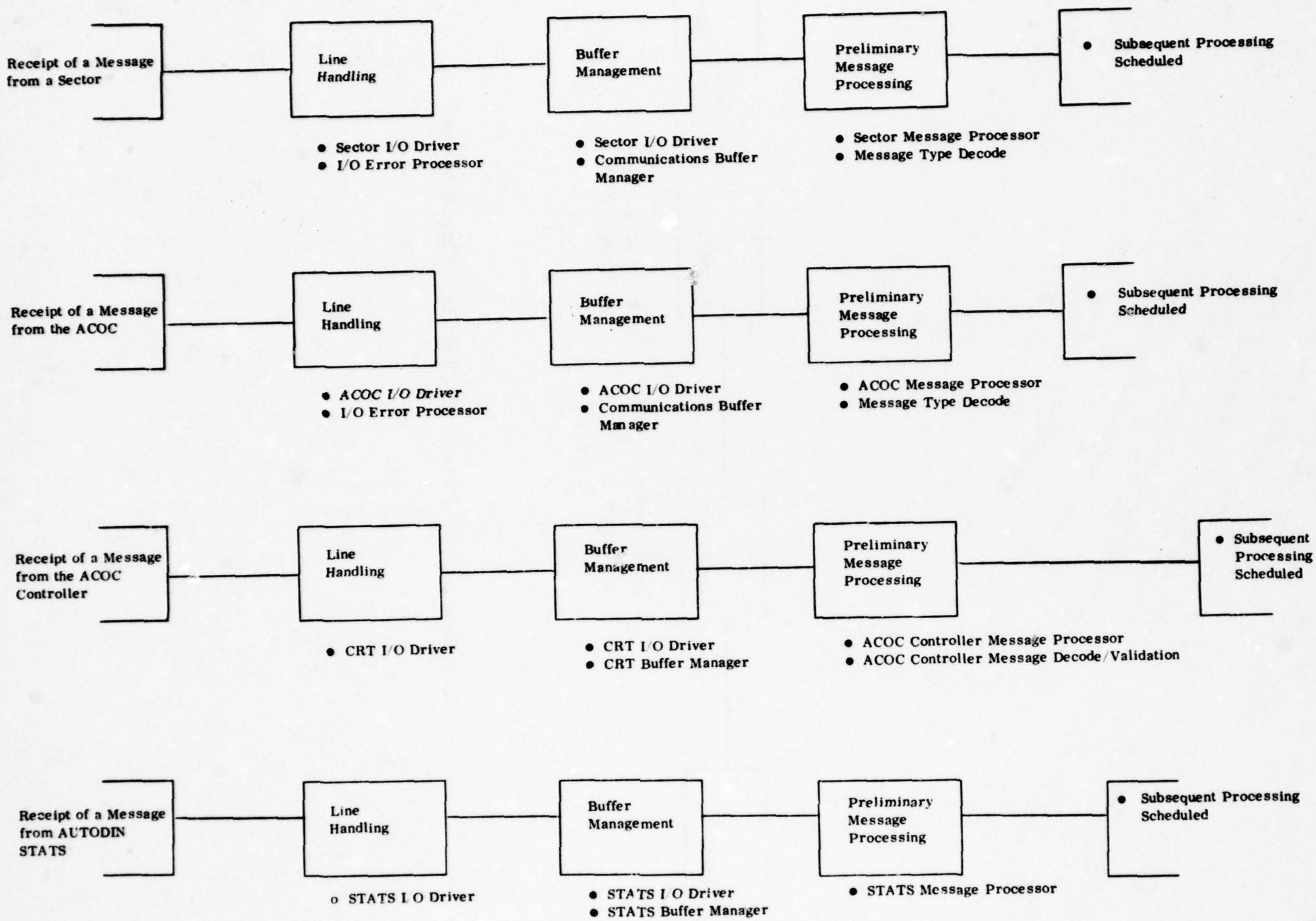


Figure 5.3-3. Supervisory and I/O Level THREAD Diagrams (Sheet 1 of 2)

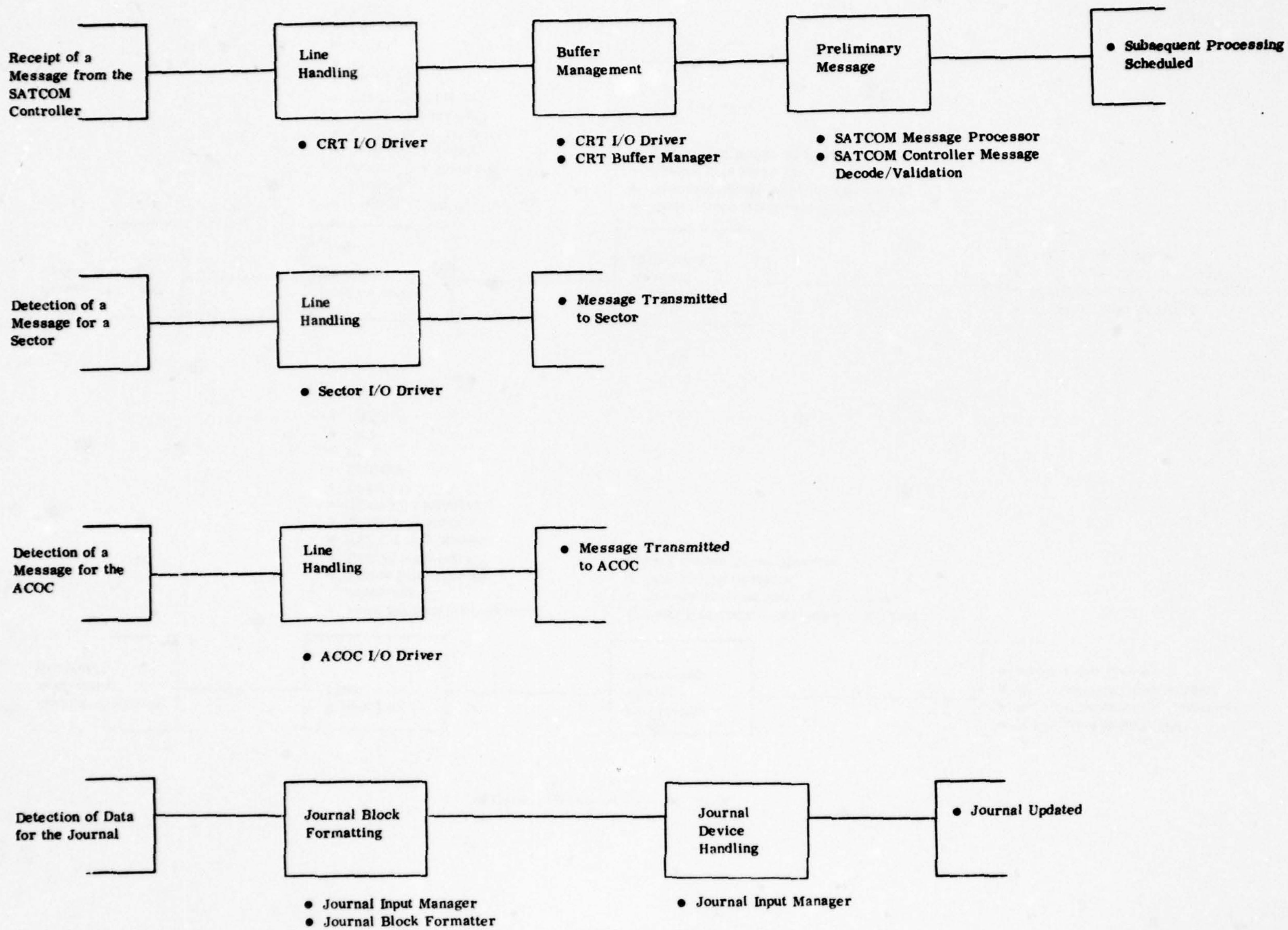


Figure 5.3-3. Supervisory and I/O Level THREAD Diagrams (Sheet 2 of 2)

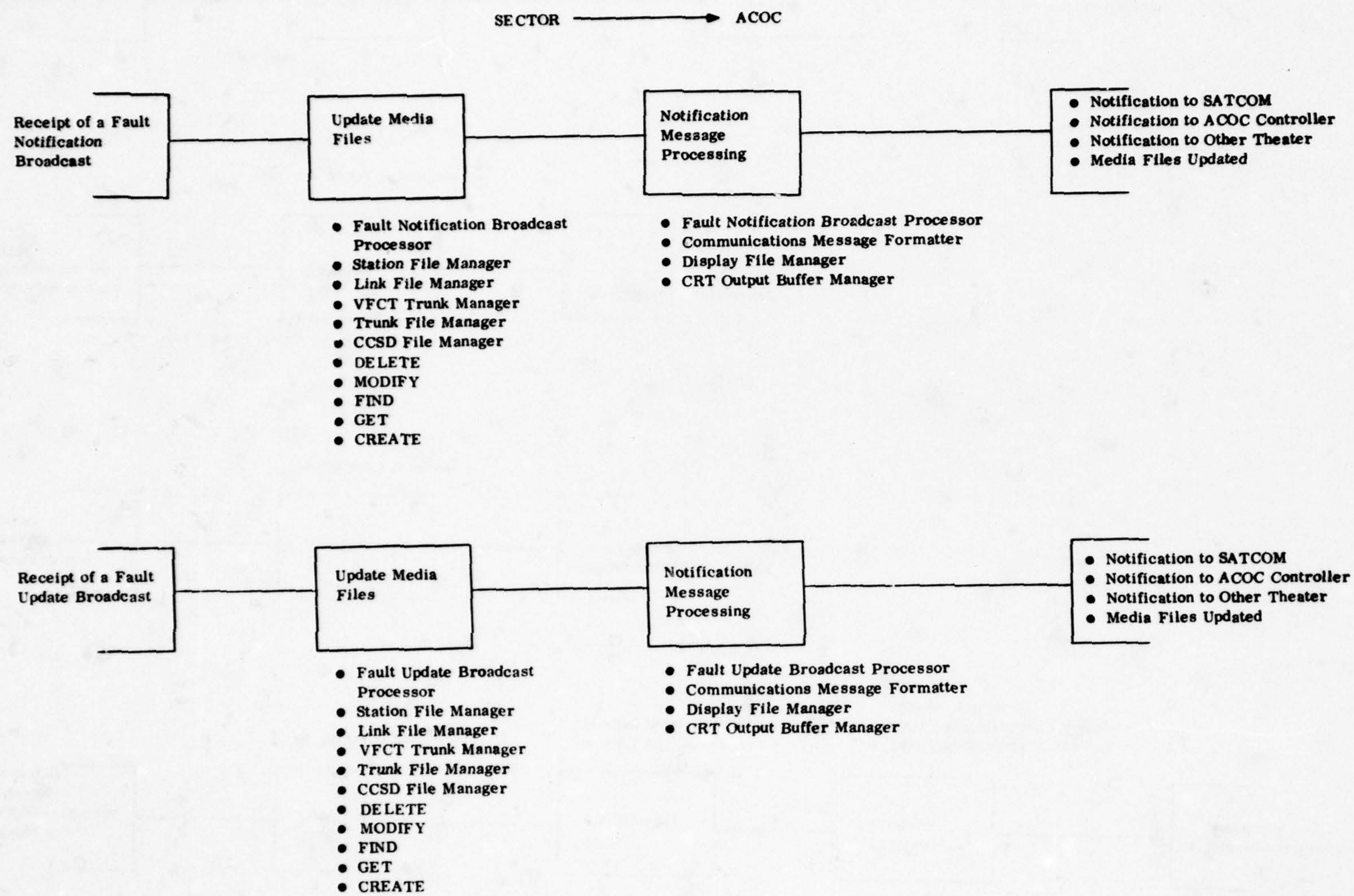


Figure 5.3-4. Sector → ACOC THREAD Diagrams (Sheet 1 of 5)

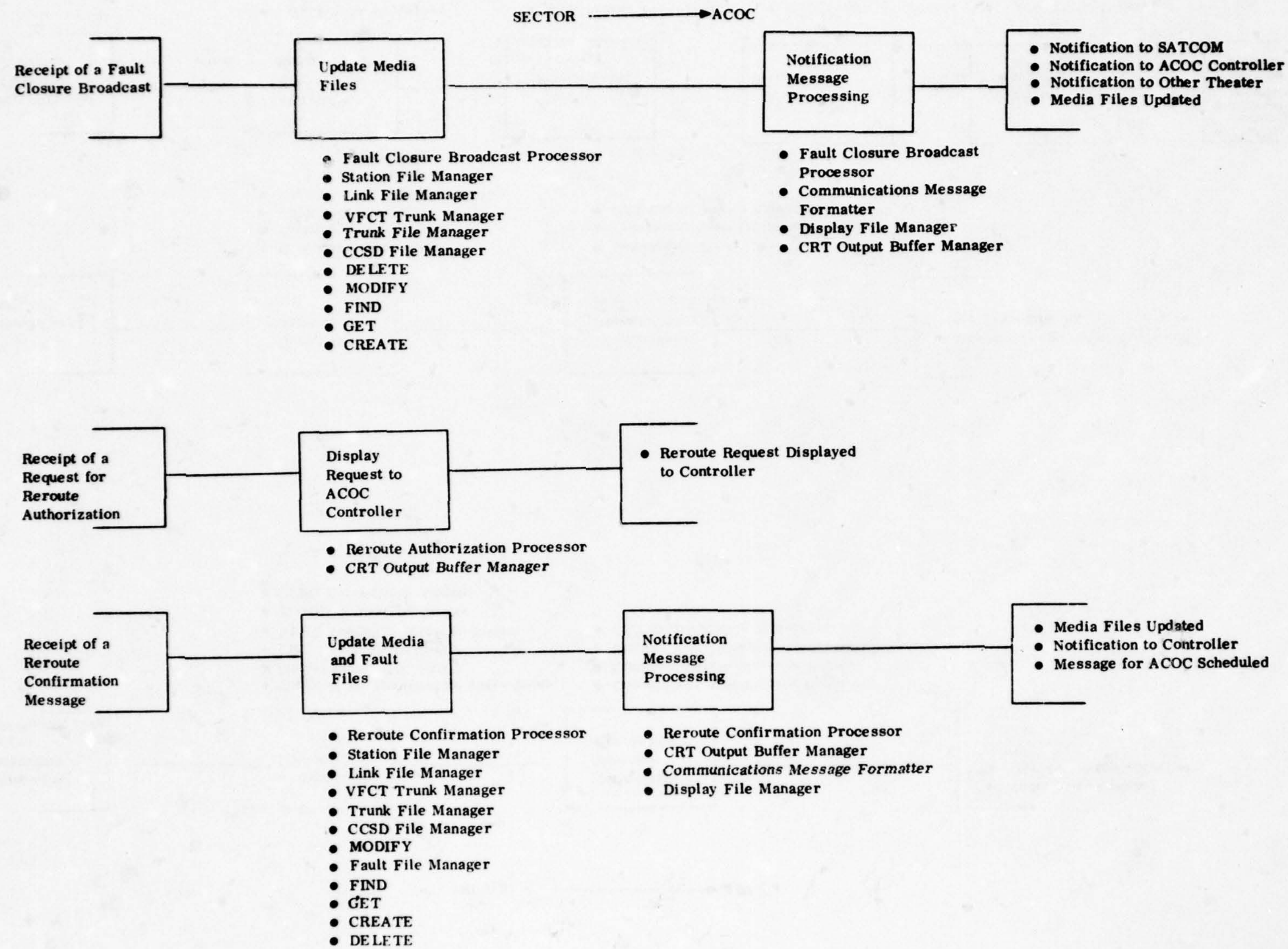


Figure 5.3-4. Sector → ACOC THREAD Diagrams (Sheet 2 of 5)

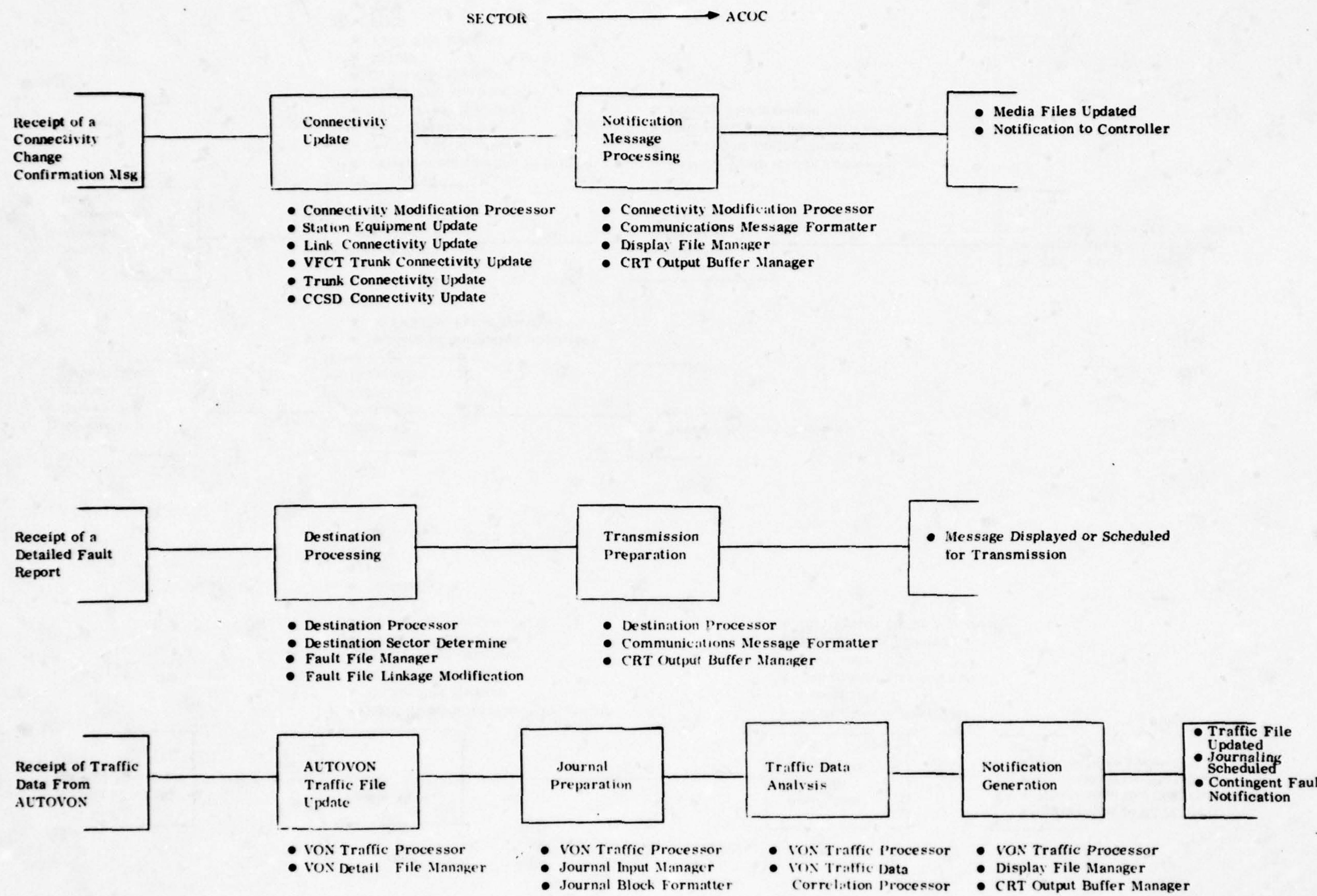


Figure 5.3-4. Sector ⟶ ACOC THREAD Diagrams (Sheet 3 of 5)

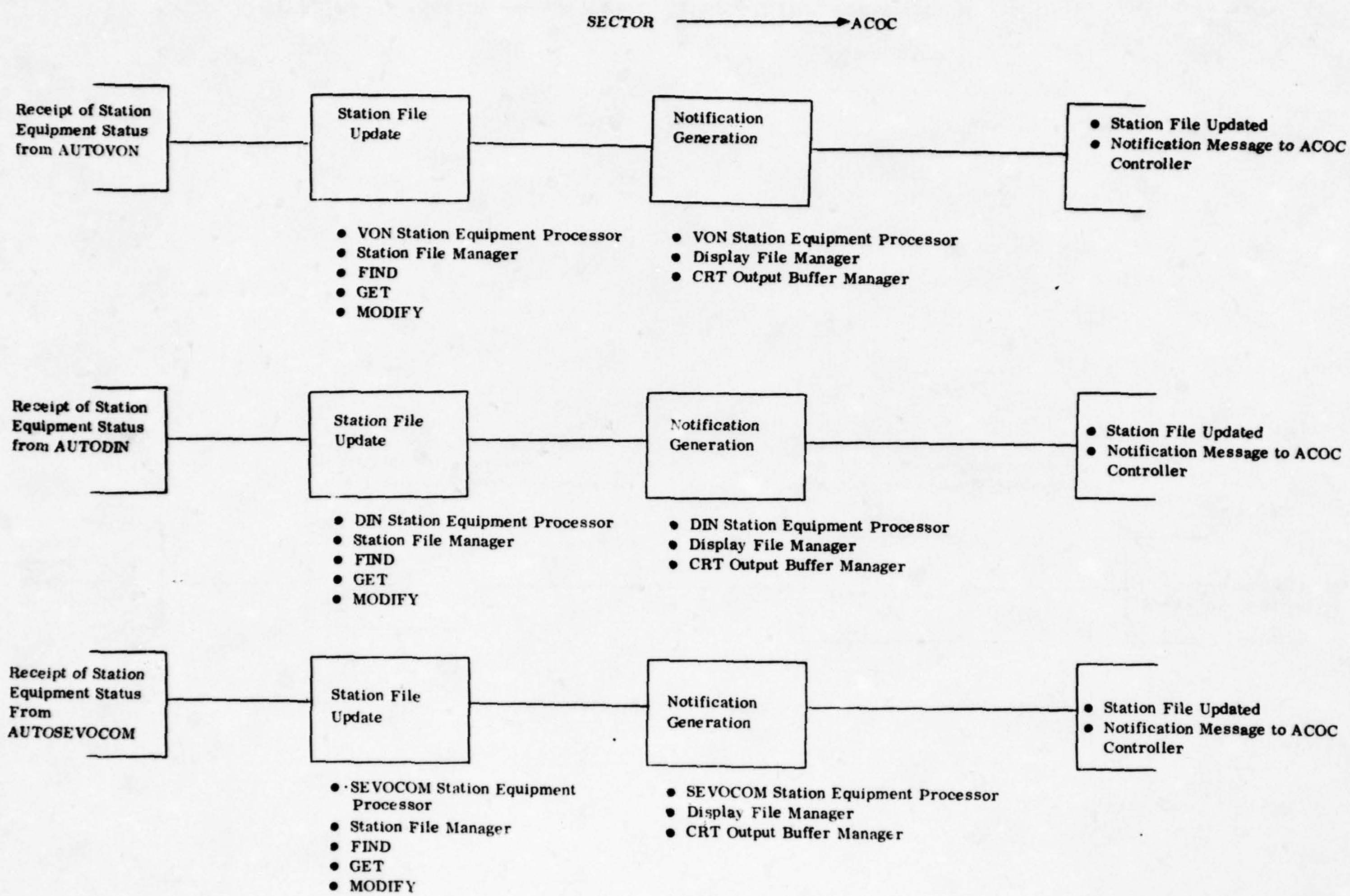


Figure 5.3-4. Sector ⟶ ACOC THREAD Diagrams (Sheet 4 of 5)

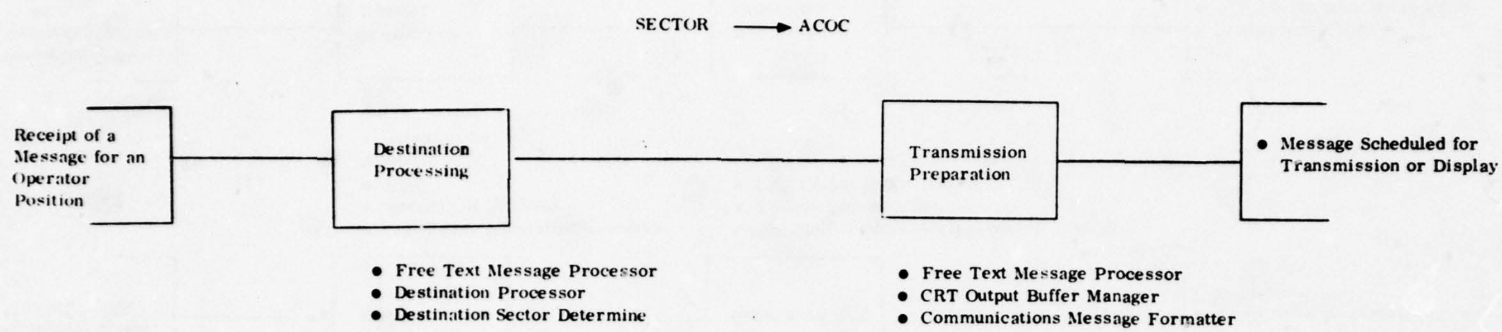


Figure 5.3-4. Sector → ACOC THREAD Diagrams (Sheet 5 of 5)

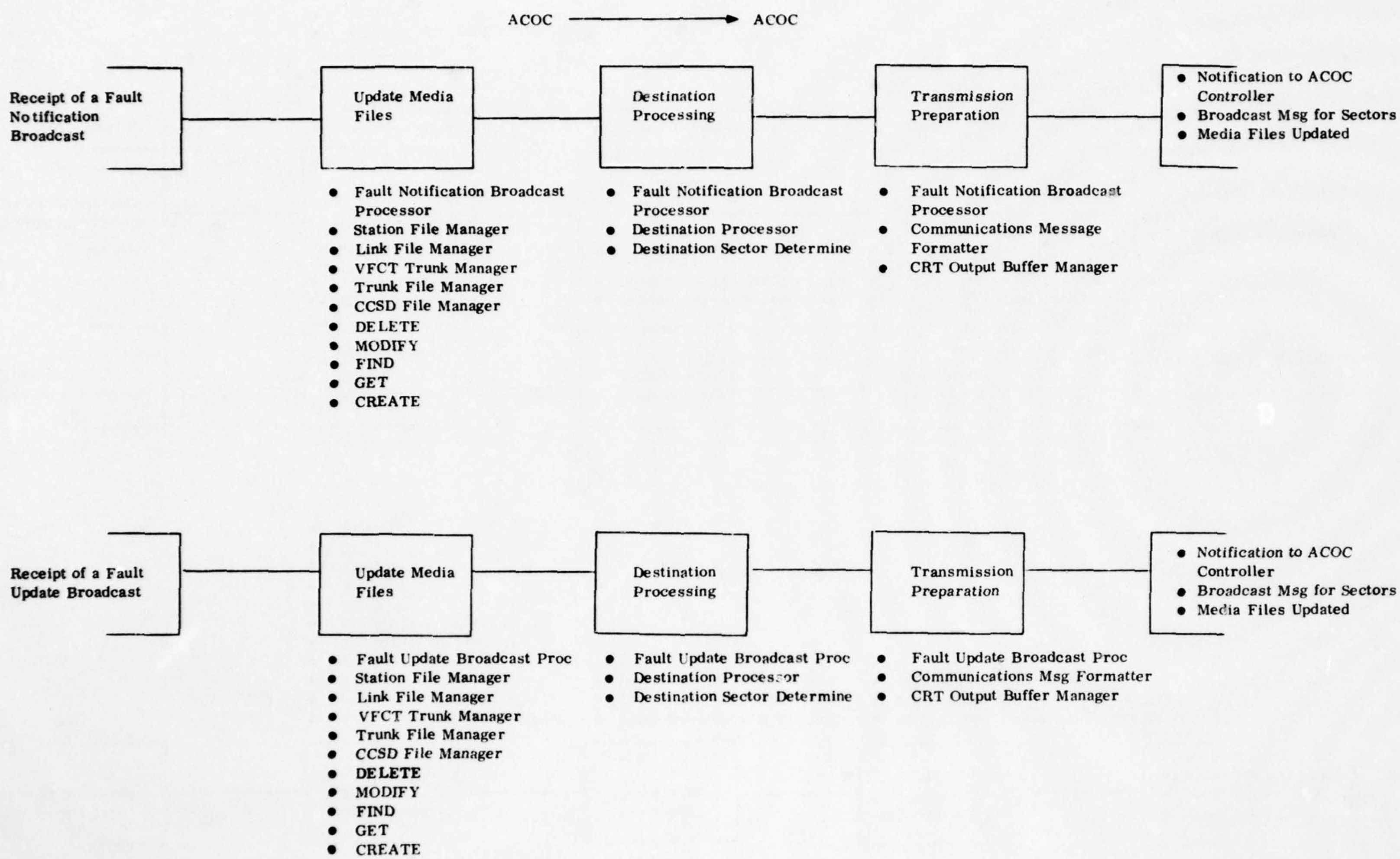


Figure 5.3-5. ACOC → ACOC THREAD Diagrams (Sheet 1 of 4)

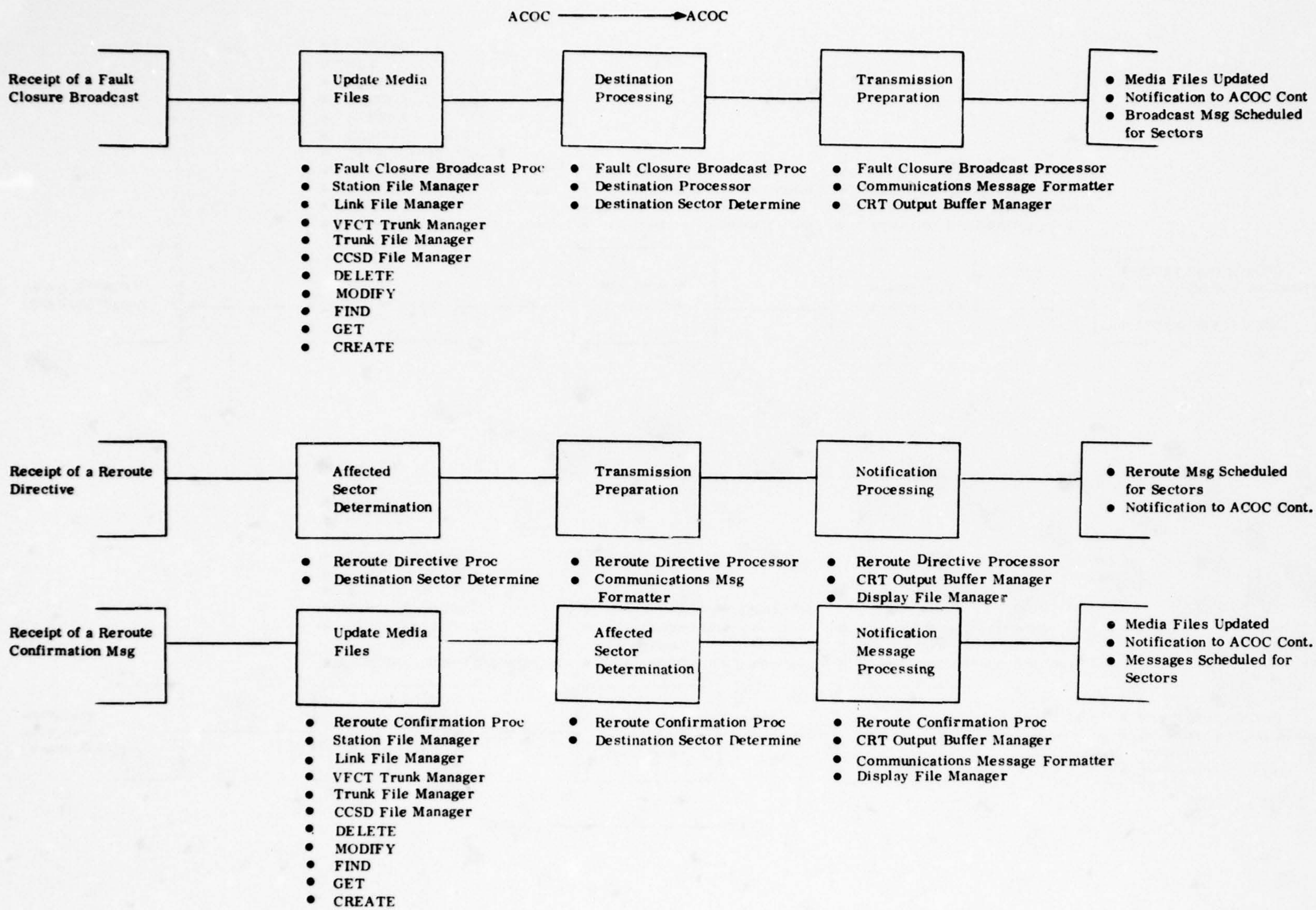


Figure 5.3-5. ACOC ——▶ ACOC THREAD Diagrams (Sheet 2 of 4)

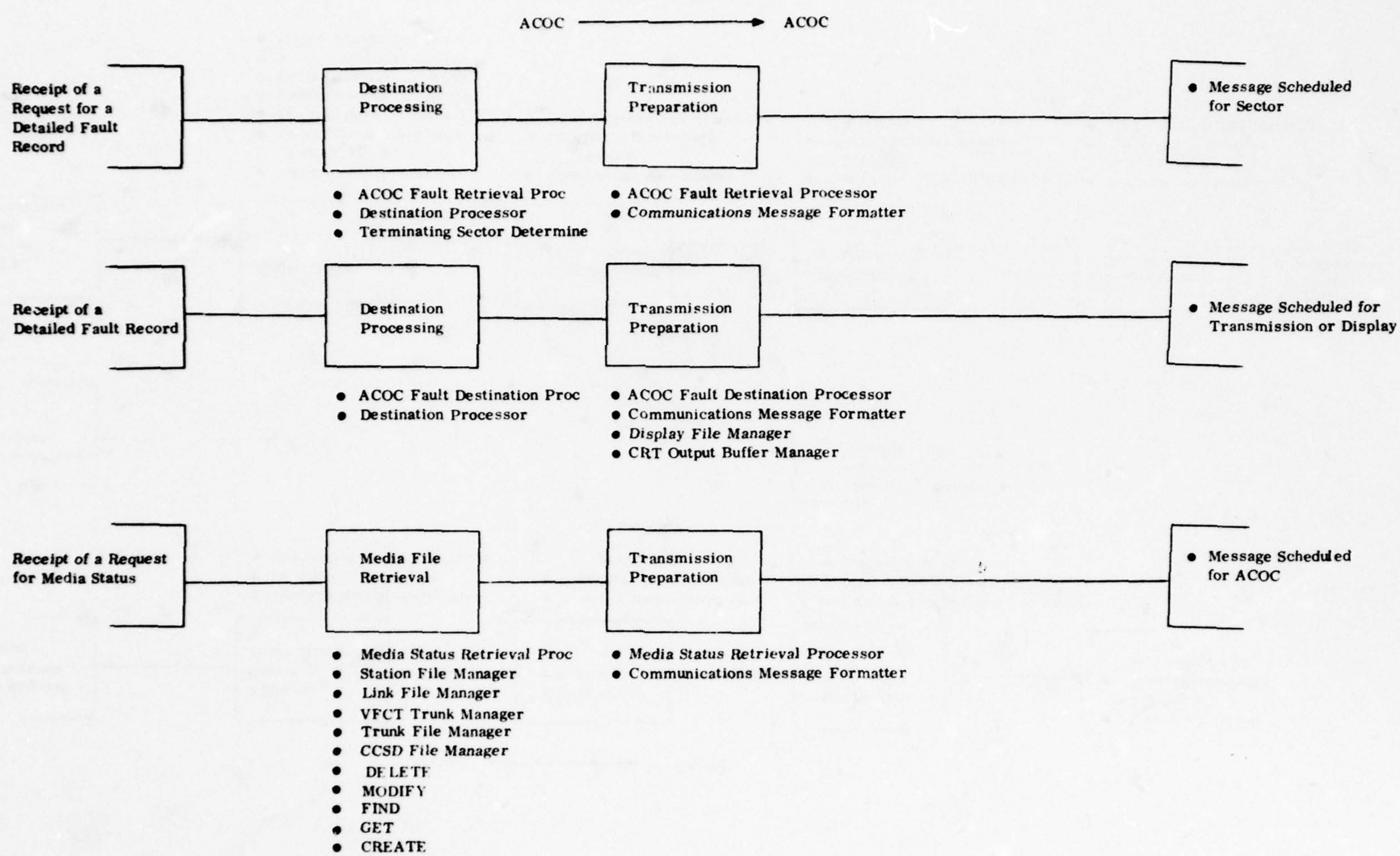


Figure 5.3-5. ACOC ⟶ ACOC THREAD Diagrams (Sheet 3 of 4)

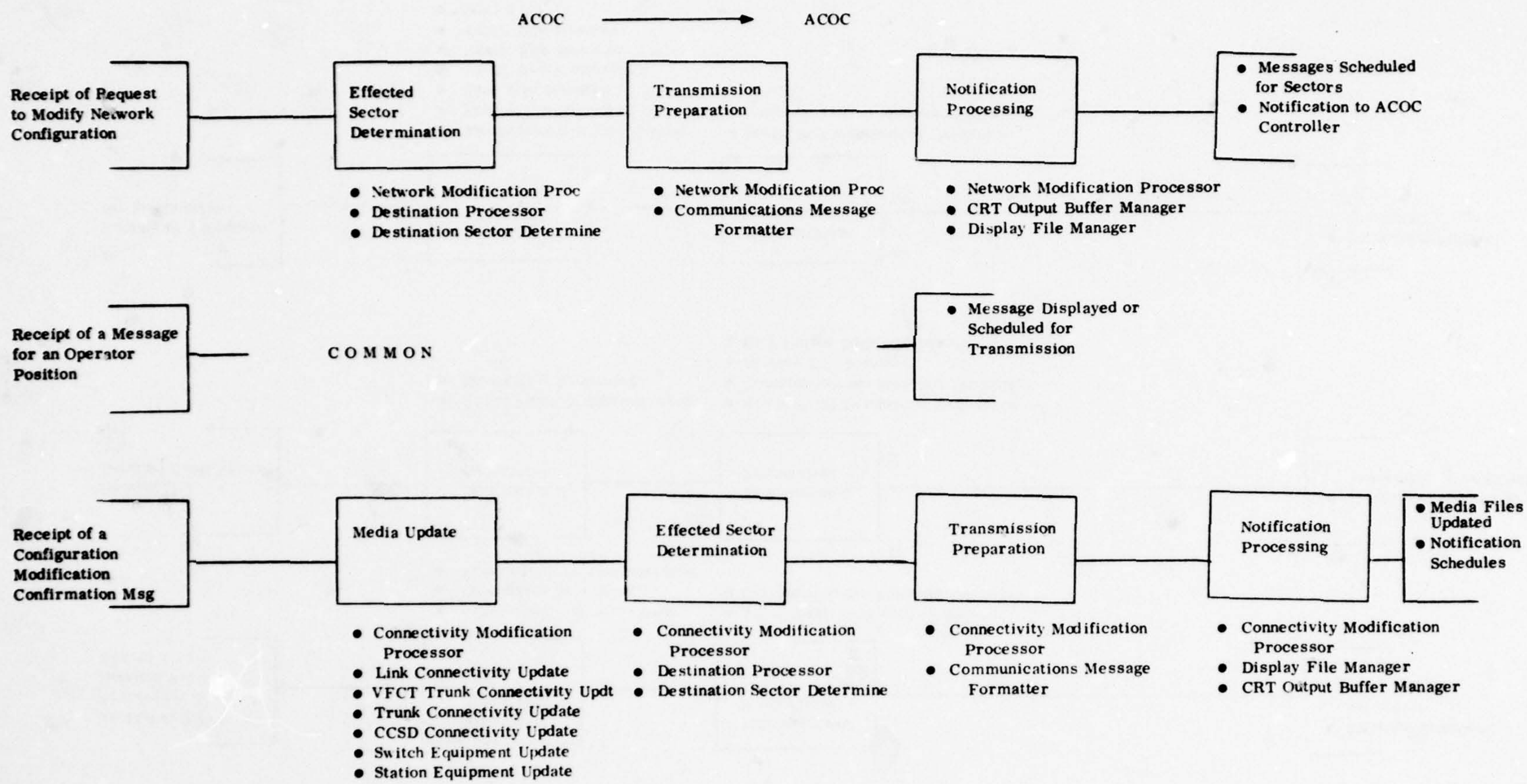


Figure 5.3-5. ACOC → ACOC THREAD Diagrams (Sheet 4 of 4)

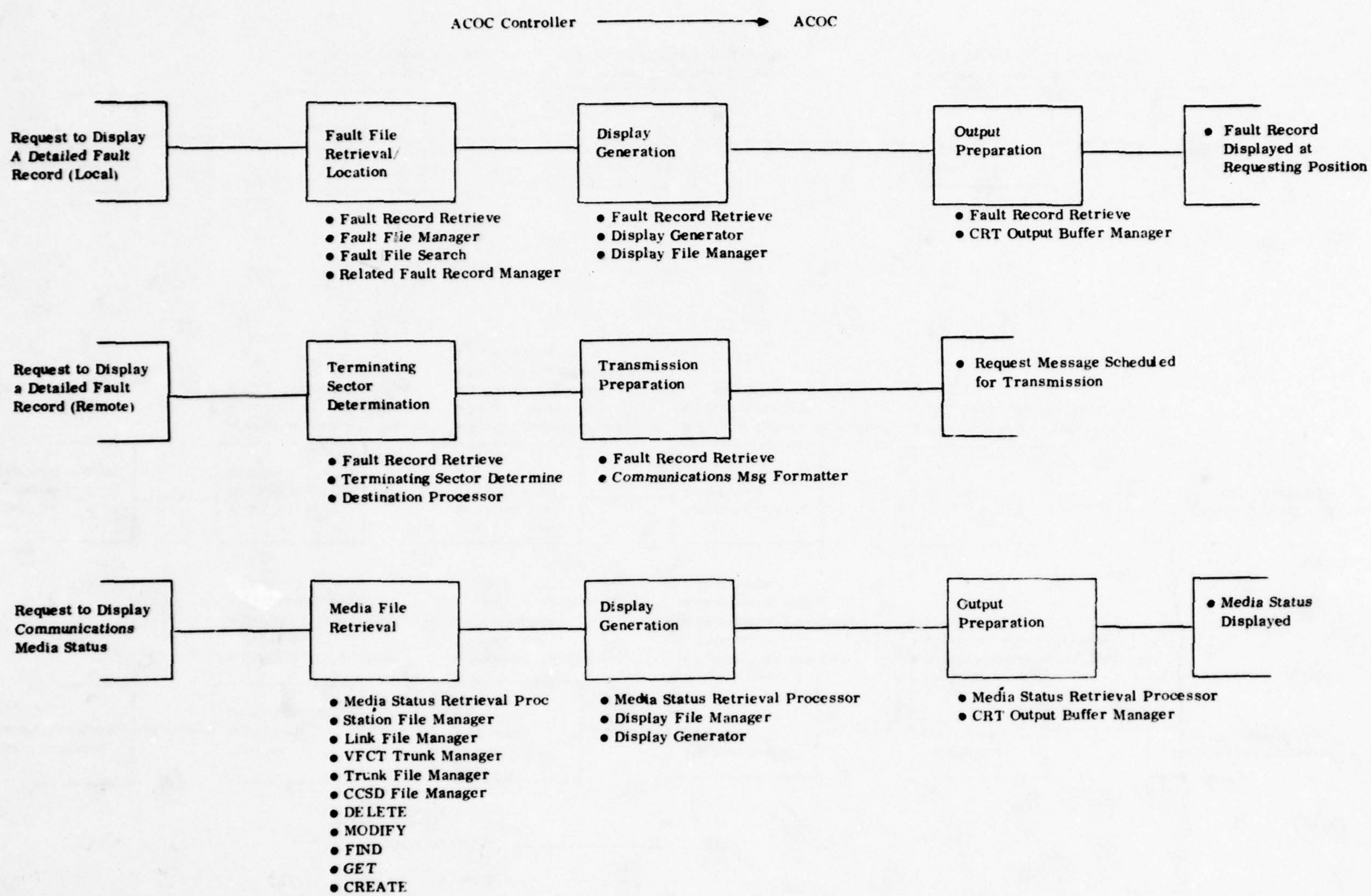


Figure 5.3-6. ACOC Controller → ACOC THREAD Diagrams (Sheet 1 of 5)

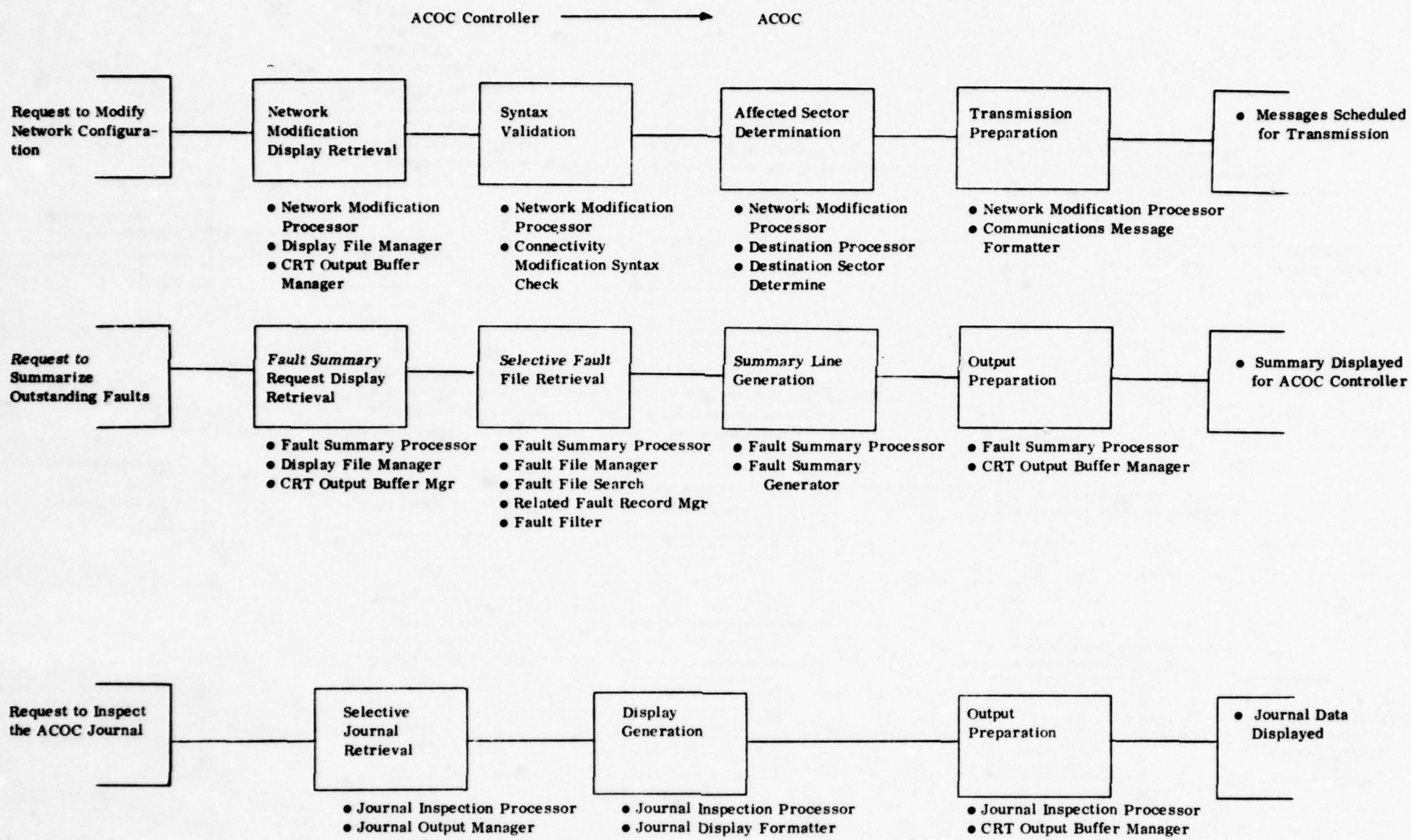


Figure 5.3-6. ACOC Controller ⟶ ACOC THREAD Diagrams (Sheet 2 of 5)

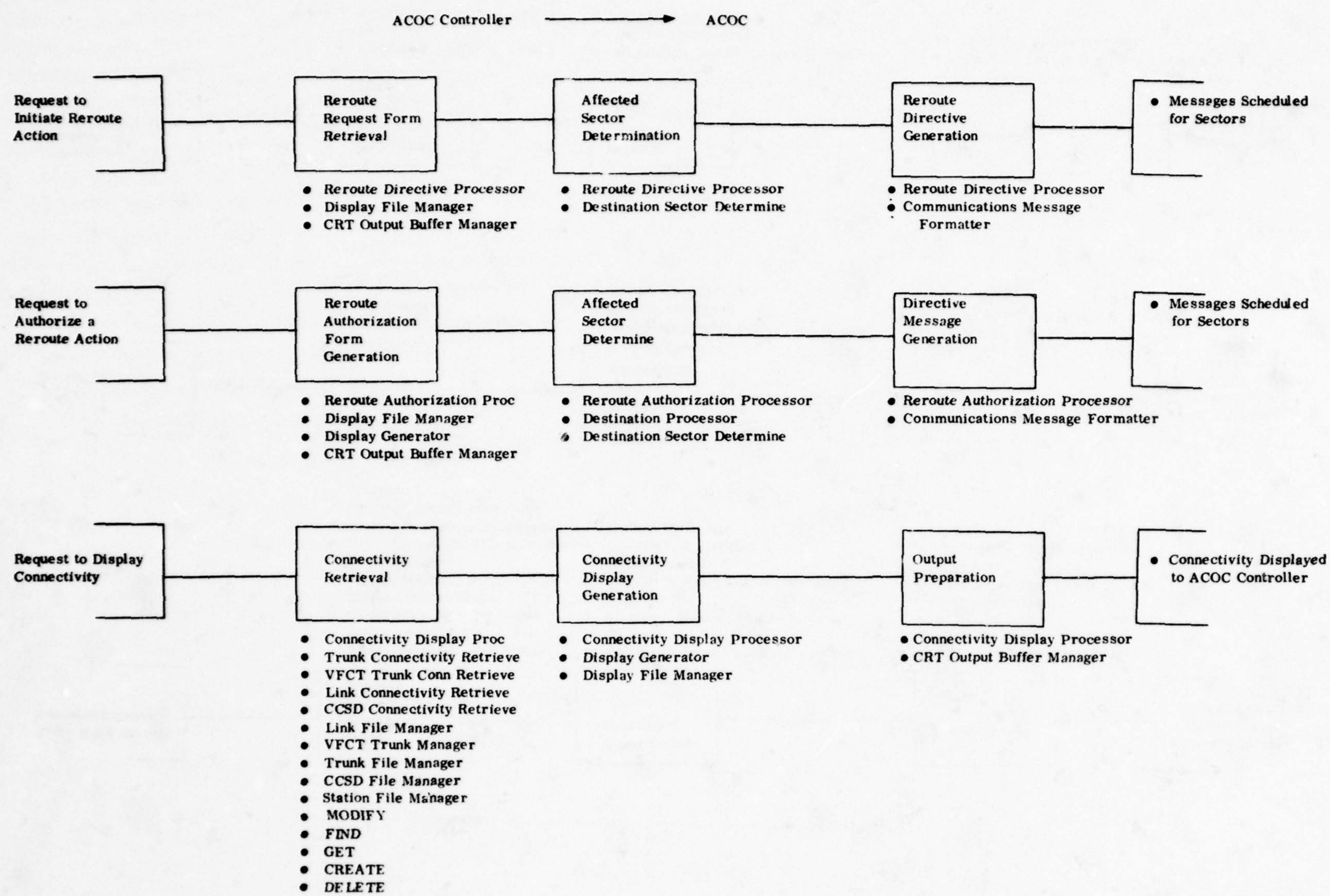


Figure 5.3-6. ACOC Controller ⟶ ACOC THREAD Diagrams (Sheet 3 of 5)

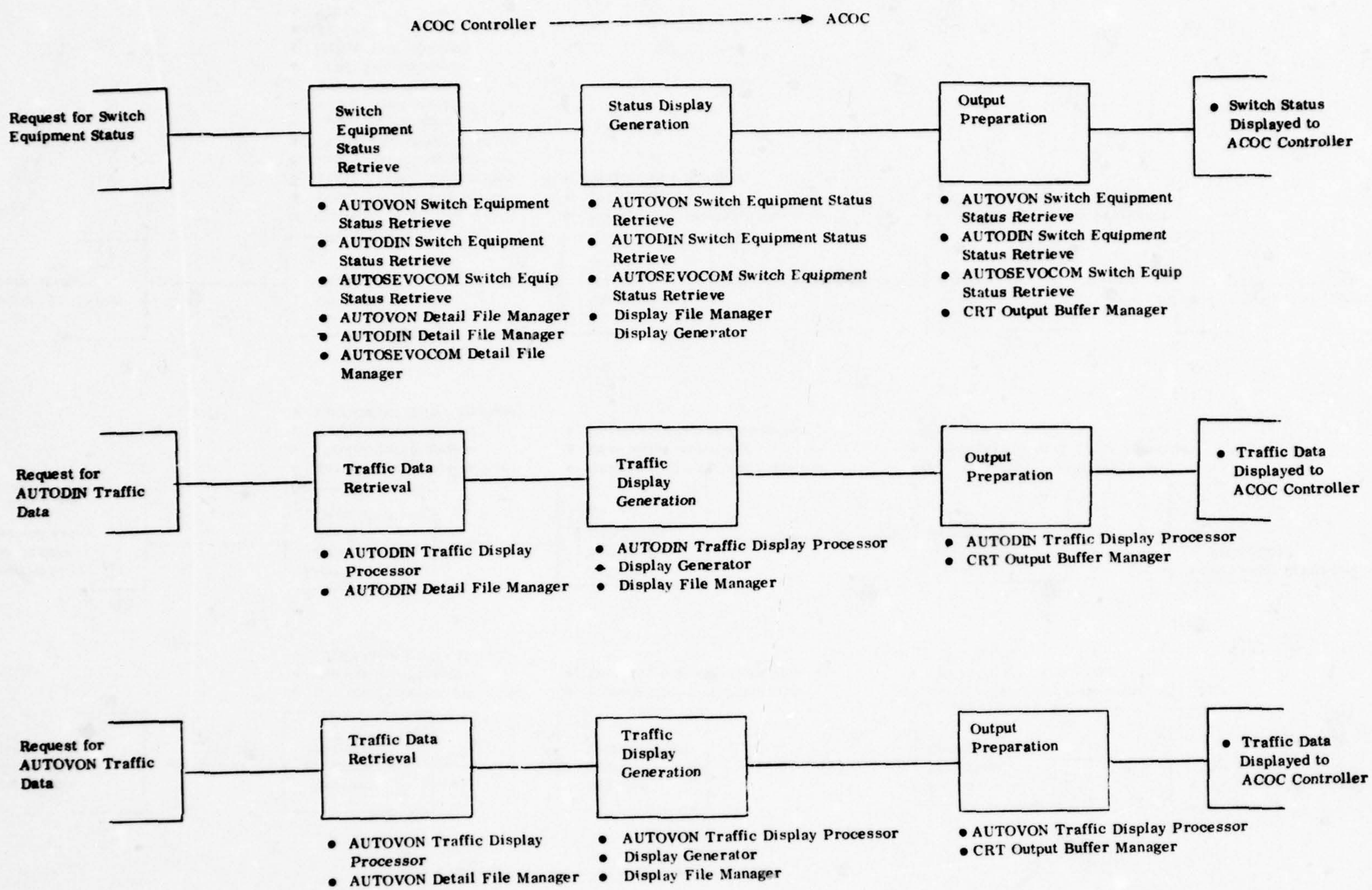


Figure 5.3-6. ACOC Controller → ACOC THREAD Diagrams (Sheet 4 of 5)

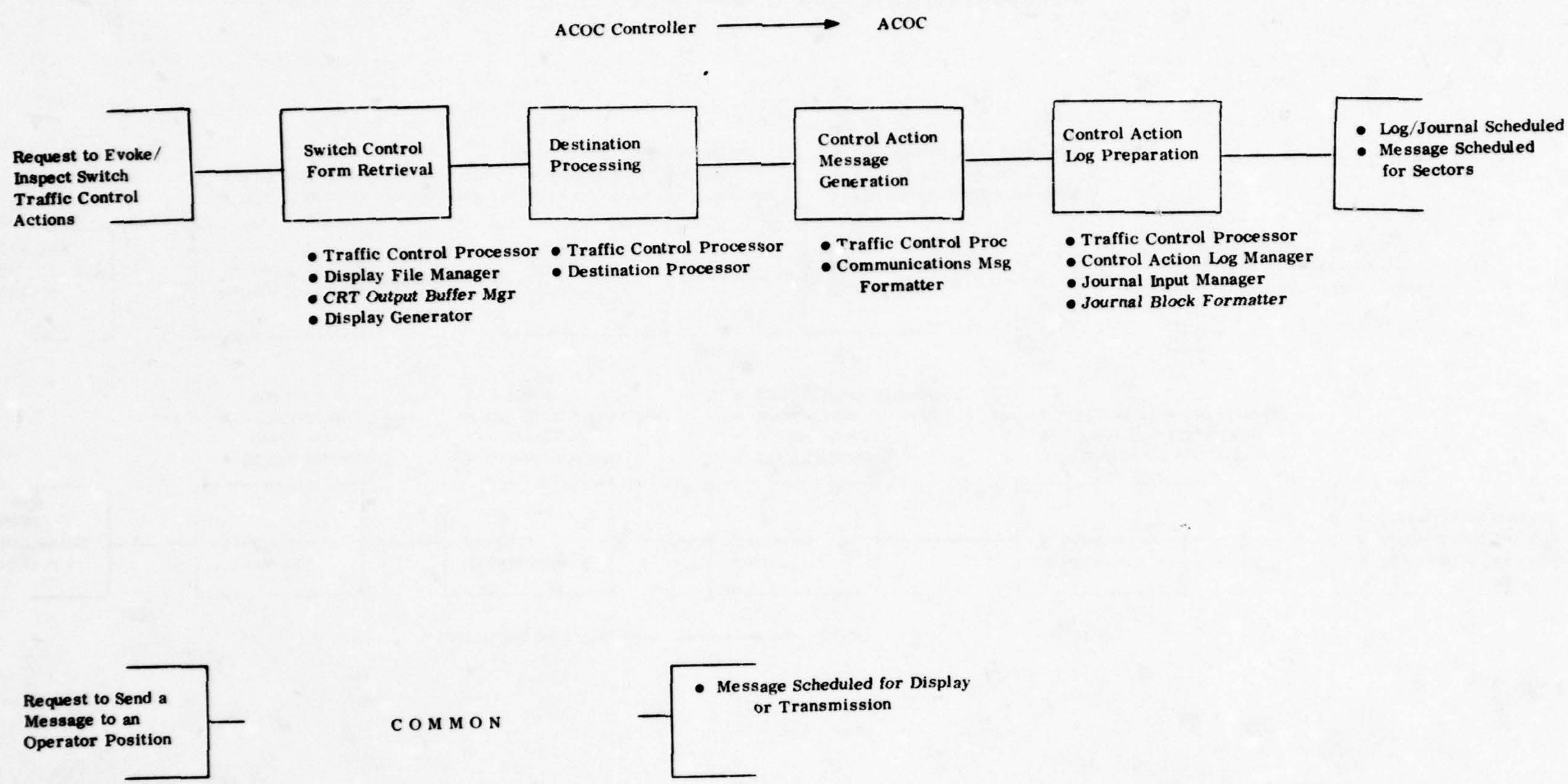


Figure 5.3-6. ACOC Controller → ACOC THREAD Diagrams (Sheet 5 of 5)

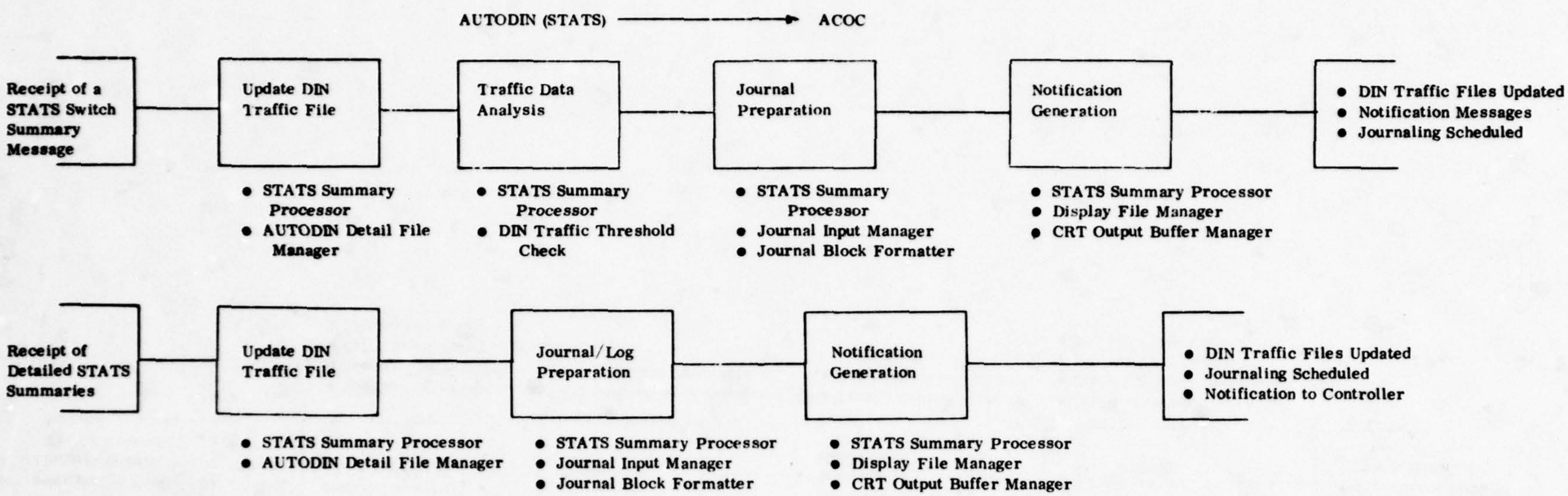


Figure 5.3-7. AUTODIN (STATS) → ACOC THREAD Diagrams

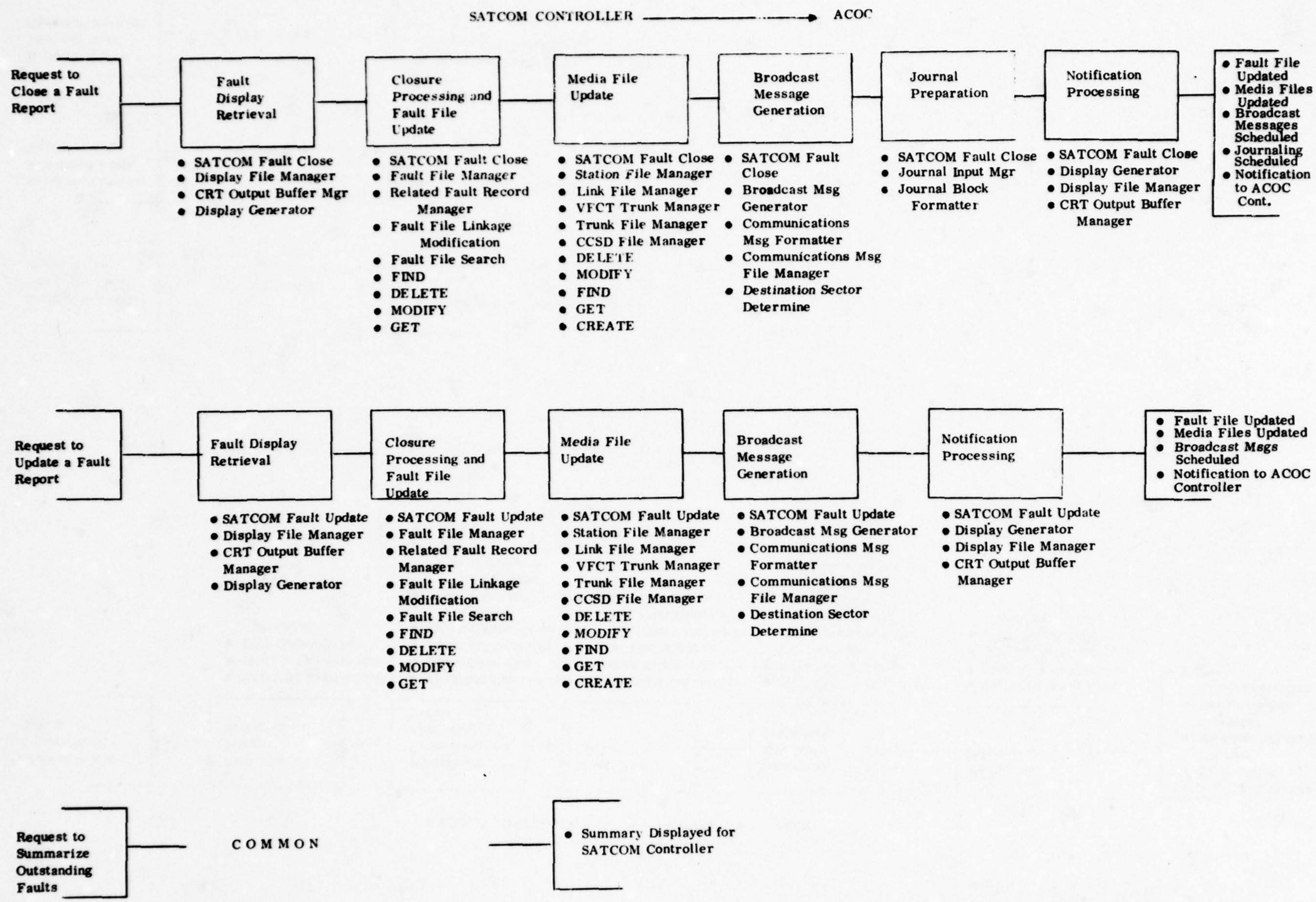


Figure 5.3-8. SATCOM Controller → ACOC THREAD Diagrams (Sheet 1 of 2)

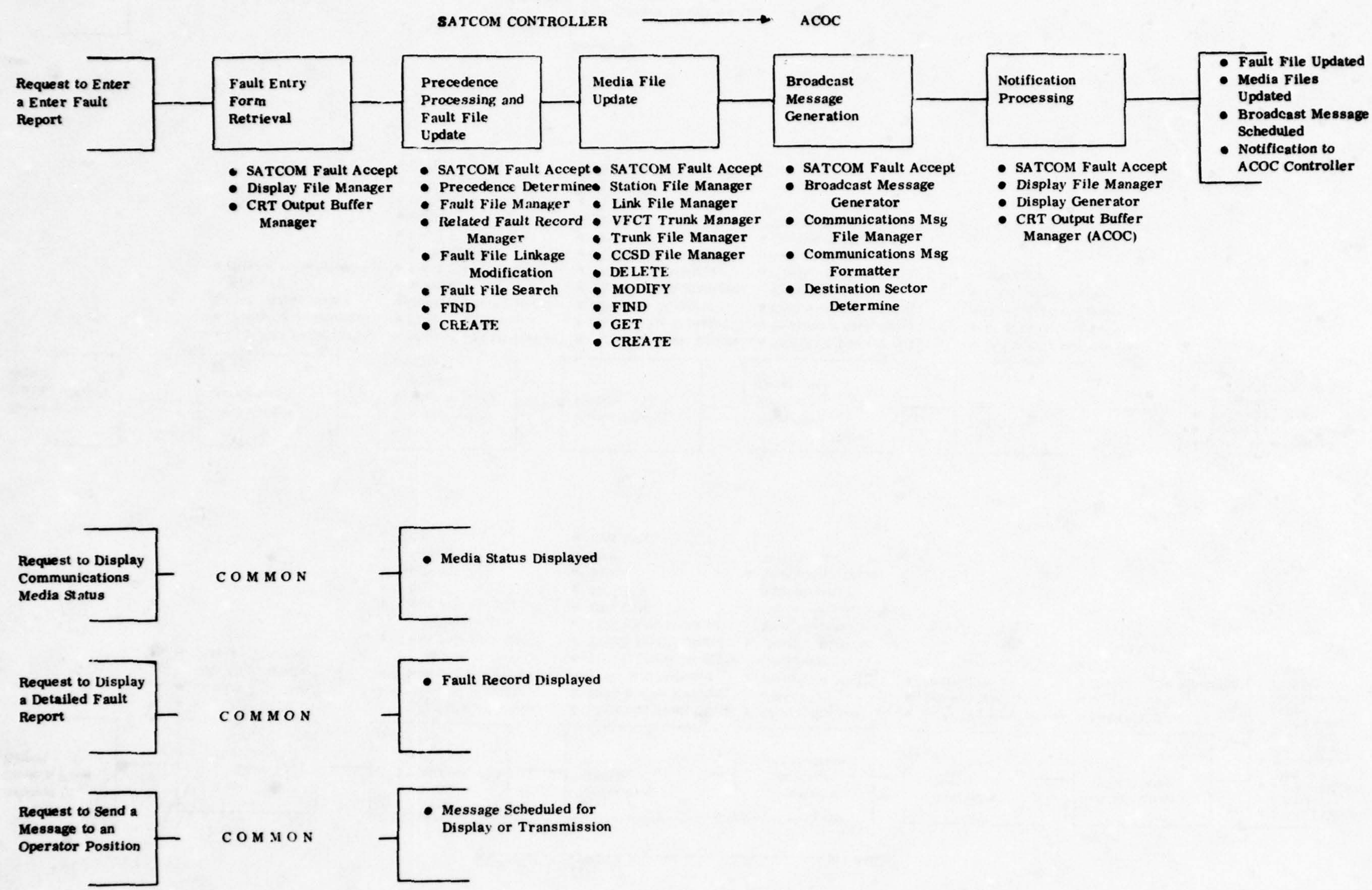
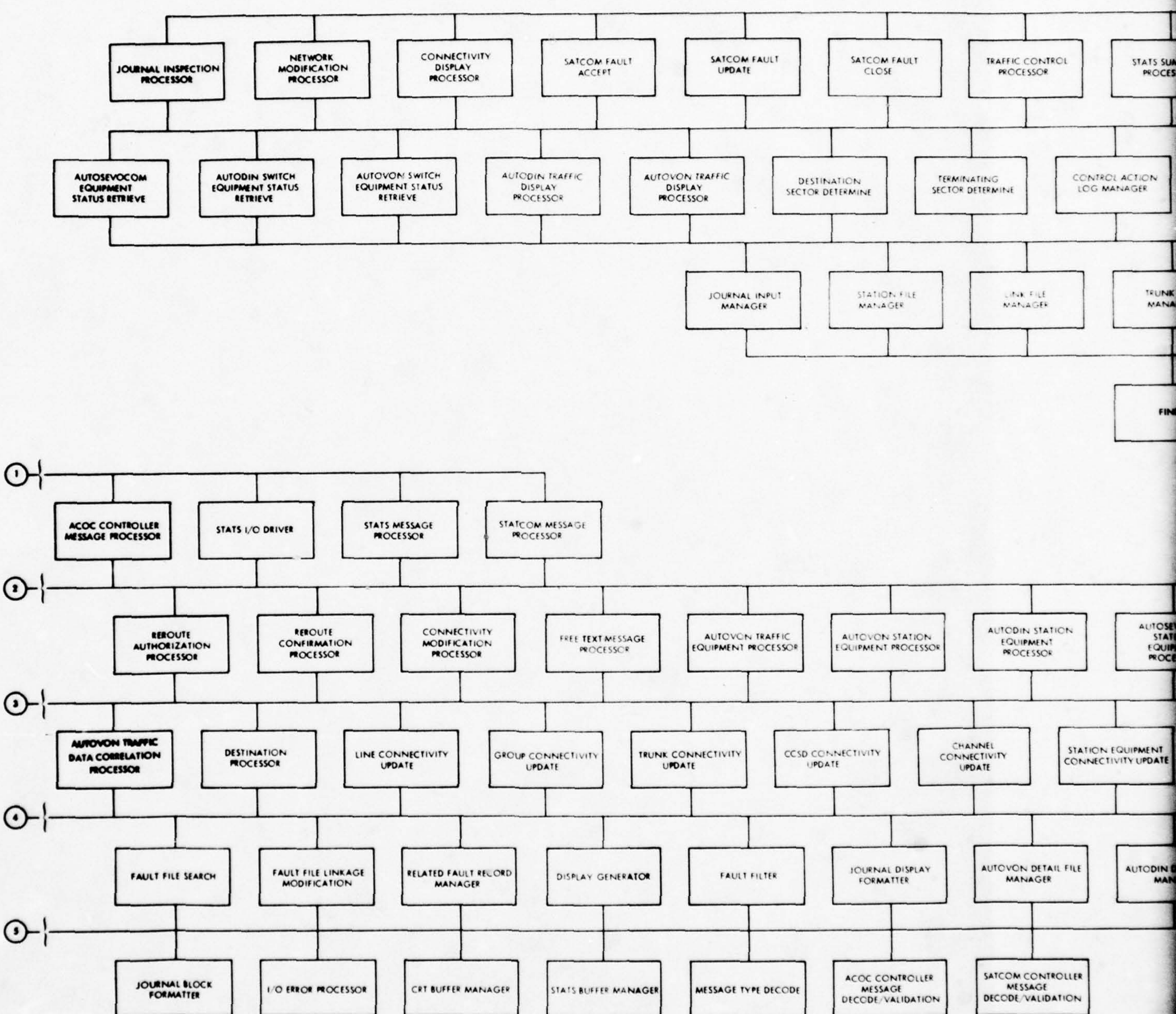


Figure 5.3-8. SATCOM Controller → ACOC THREAD Diagrams (Sheet 2 of 2)


JOURNAL INSPECTION PROCESSOR
NETWORK MODIFICATION PROCESSOR
CONNECTIVITY DISPLAY PROCESSOR
SATCOM FAULT ACCEPT
SATCOM FAULT UPDATE
SATCOM FAULT CLOSE
TRAFFIC CONTROL PROCESSOR
AUTOSEVOCOM EQUIPMENT STATUS RETRIEVE
AUTODIN SWITCH EQUIPMENT STATUS RETRIEVE
AUTOVON SWITCH EQUIPMENT STATUS RETRIEVE
AUTODIN TRAFFIC DISPLAY PROCESSOR
AUTOVON TRAFFIC DISPLAY PROCESSOR
DESTINATION SECTOR DETERMINE
TERMINATING SECTOR DETERMINE
CONTROL ACTION LOG MANAGER
JOURNAL INPUT MANAGER
STATION FILE MANAGER
LINK FILE MANAGER
1
ACOC CONTROLLER MESSAGE PROCESSOR
STATS I/O DRIVER
STATS MESSAGE PROCESSOR
STATCOM MESSAGE PROCESSOR
2
REROUTE AUTHORIZATION PROCESSOR
REROUTE CONFIRMATION PROCESSOR
CONNECTIVITY MODIFICATION PROCESSOR
FREE TEXT MESSAGE PROCESSOR
AUTOVON TRAFFIC EQUIPMENT PROCESSOR
AUTOVON STATION EQUIPMENT PROCESSOR
AUTODIN STATION EQUIPMENT PROCESSOR
3
AUTOVON TRAFFIC DATA CORRELATION PROCESSOR
DESTINATION PROCESSOR
LINE CONNECTIVITY UPDATE
GROUP CONNECTIVITY UPDATE
TRUNK CONNECTIVITY UPDATE
CCSD CONNECTIVITY UPDATE
CHANNEL CONNECTIVITY UPDATE
STATION EQUIPMENT CONNECTIVITY UPDATE
4
FAULT FILE SEARCH
FAULT FILE LINKAGE MODIFICATION
RELATED FAULT RECORD MANAGER
DISPLAY GENERATOR
FAULT FILTER
JOURNAL DISPLAY FORMATTER
AUTOVON DETAIL FILE MANAGER
5
JOURNAL BLOCK FORMATTER
I/O ERROR PROCESSOR
CRT BUFFER MANAGER
STATS BUFFER MANAGER
MESSAGE TYPE DECODE
ACOC CONTROLLER MESSAGE DECODE/VALIDATION
SATCOM CONTROLLER MESSAGE DECODE/VALIDATION

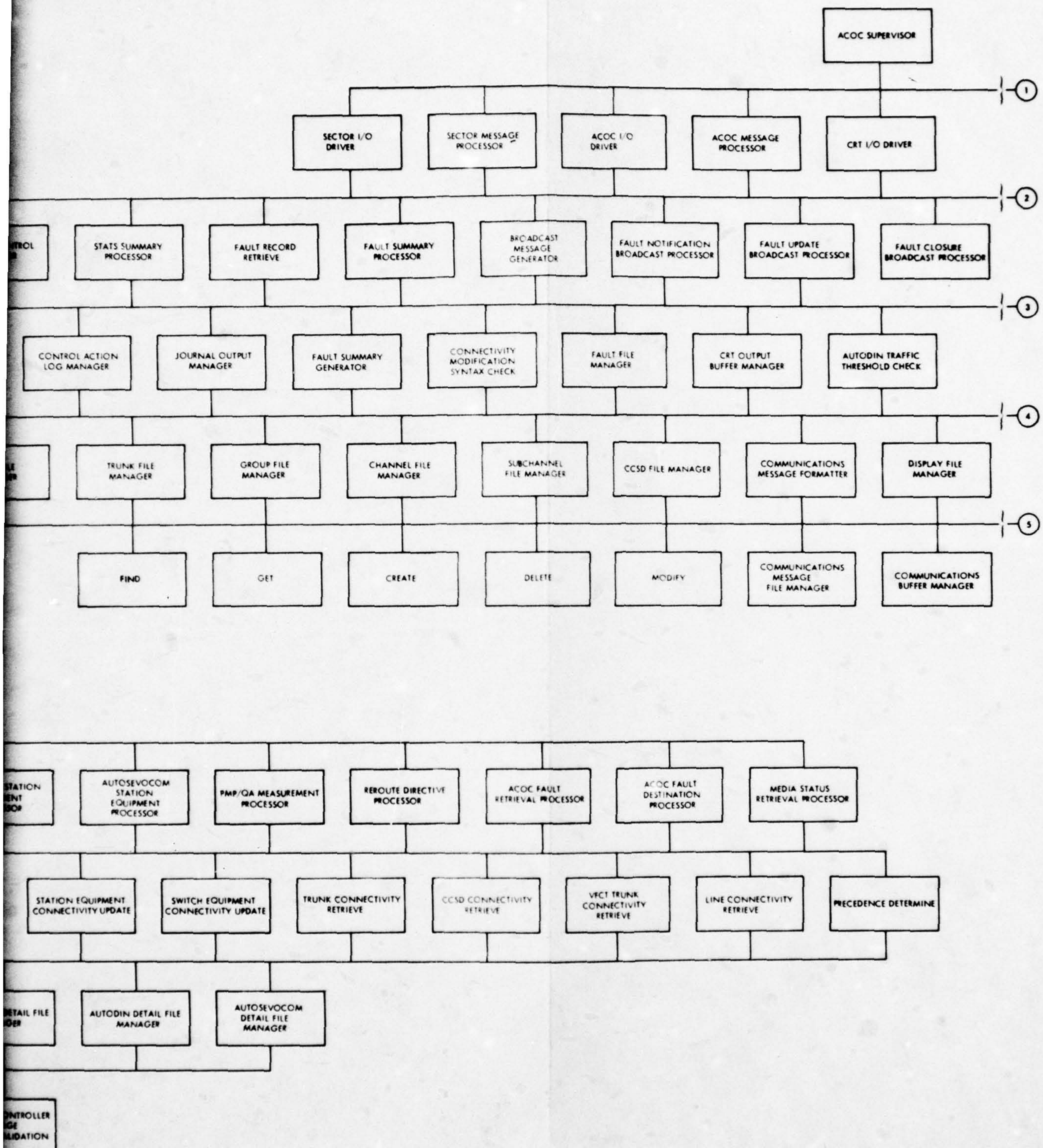


Figure 5.3-9. Computer Programs Hierarchy for the ACOC

ACOC Processing Load:

$$P_A = P_{SECTOR} + P_{ACOC} + P_{STATS} + P_{SATCOM} + P_{DISK} + P_{I/O} \tag{1}$$

$$P_A = L_{SECTOR}\, R_{SECTOR} + L_{ACOC}\, R_{ACOC} + L_{STATS}\, R_{STATS} + L_{SATCOM}\, R_{SATCOM}\, P_{DISK} + P_{I/O} \tag{2}$$

where

L_X = Load due to X

R_X = Rate of occurrence of X

$$\begin{aligned} L_{SECTOR} &= (I_{SECTOR})\ (\text{Time conversion}) \\ &= (I_{A1})\ (\frac{MIN}{SEC}) \\ &= (1005)\ (1/60) \\ &= 16.75 \end{aligned} \tag{3}$$

$$\begin{aligned} L_{ACOC} &= (I_{A2})\ (\frac{MIN}{SEC}) \\ &= (2475)\ (1/60) \\ &= 41.25 \end{aligned} \tag{4}$$

$$\begin{aligned} L_{STATS} &= (I_{A3})\ (\frac{MIN}{SEC}) \\ &= (2500)\ (1/60) \\ &= 41.67 \end{aligned} \tag{5}$$

$$\begin{aligned} L_{SATCOM} &= (I_{A4})\ (\frac{MIN}{SEC}) \\ &= (5445)\ (1/60) \\ &= 90.75 \end{aligned} \tag{6}$$

$$P_{DISK} = 256\ D_A \tag{7}$$

Figure 5.3-10. Derivation of the ACOC Processing Load

where

D_A = Disk Load (see Figure 5.3-12)

$P_{I/O}$ = 16,290 (see Table 5.3-7) (8)

so

$$P_A = 16.75\ R_{SECTOR} + 41.25\ R_{ACOC} + 41.67\ R_{STATS} + 90.75\ R_{SATCOM} + 256\ D_A + 16{,}290 \quad (9)$$

Figure 5.3-10. Derivation of the ACOC Processing Load (Cont'd)

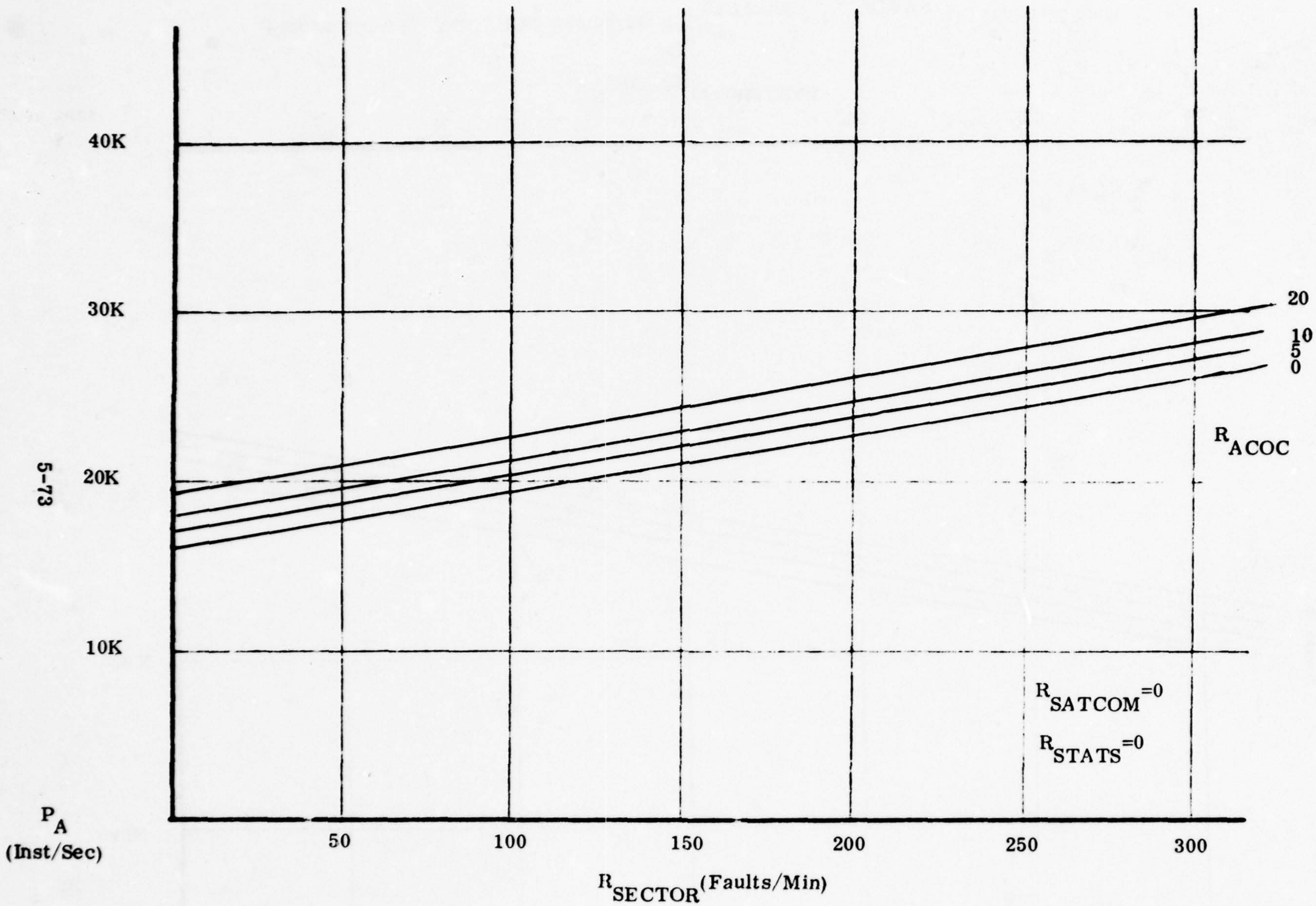


Figure 5.3-11. ACOC Processing Load ($R_{SATCOM} = 0$, $R_{STATS} = 0$) (Sheet 1 of 2)

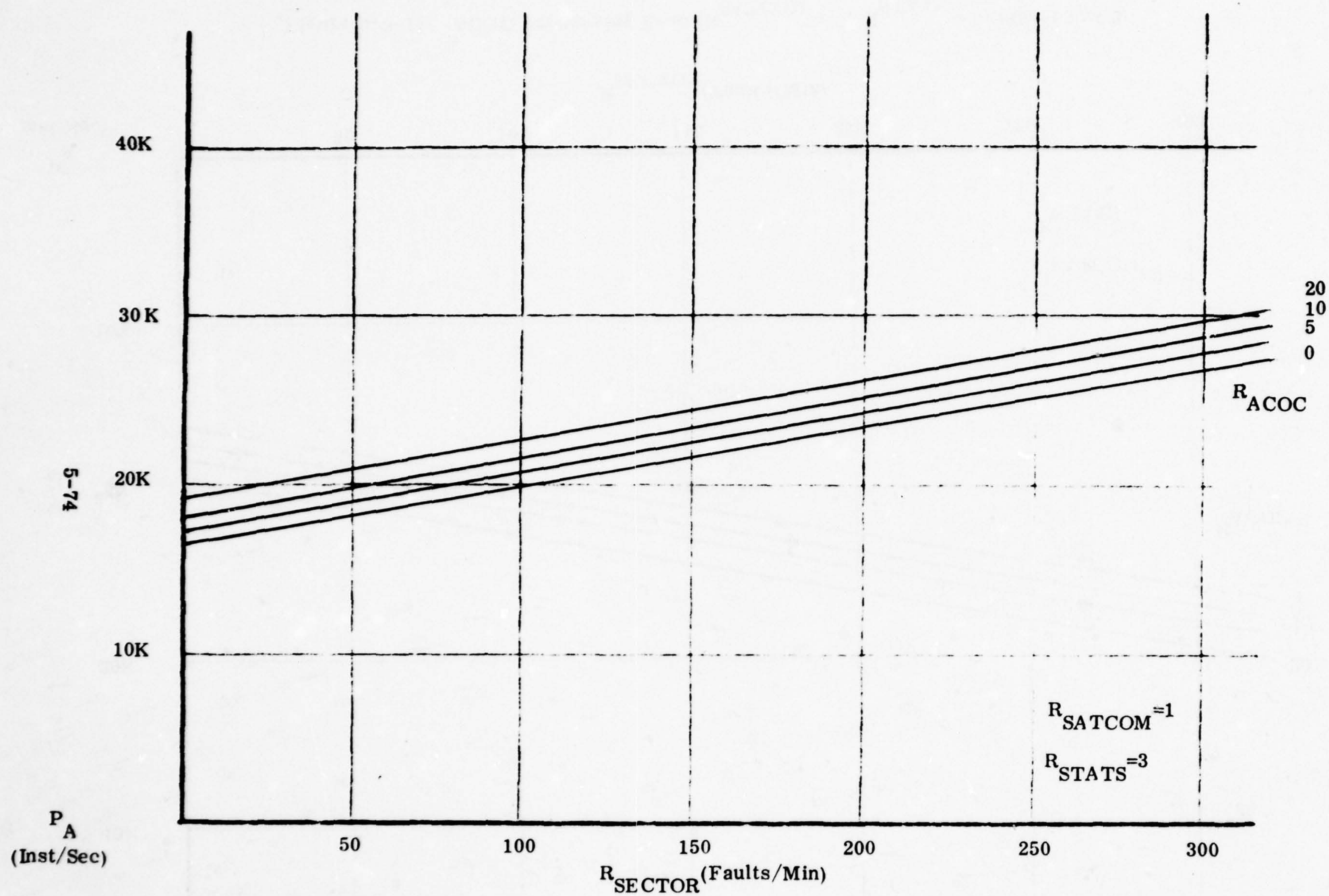


Figure 5.3-11. ACOC Processing Load (R_{SATCOM} = 1, R_{STATS} = 3) (Sheet 2 of 2)

ACOC Disk Load:

$$D_A = D_{SECTOR} + D_{ACOC} + D_{STATS} + D_{SATCOM} \tag{1}$$

$$D_A = A_{SECTOR} R_{SECTOR} + A_{ACOC} R_{ACOC} + A_{STATS} R_{STATS} + A_{SATCOM} R_{SATCOM} \tag{2}$$

where

A_X = Number of accesses due to X

R_X = Rate of occurrence of X

$$\begin{aligned} A_{SECTOR} &= (A_{A1}) \left(\frac{MIN}{SEC}\right) \\ &= (4)\ (1/60) \\ &= .07 \end{aligned} \tag{3}$$

$$\begin{aligned} A_{ACOC} &= (A_{A2}) \left(\frac{MIN}{SEC}\right) \\ &= (16)\ (1/60) \\ &= .27 \end{aligned} \tag{4}$$

$$\begin{aligned} A_{STATS} &= (A_{A3}) \left(\frac{MIN}{SEC}\right) \\ &= (3)\ (1/60) \\ &= .05 \end{aligned} \tag{5}$$

$$\begin{aligned} A_{SATCOM} &= (A_{A4}) \left(\frac{MIN}{SEC}\right) \\ &= (26)\ (1/60) \\ &= .43 \end{aligned} \tag{6}$$

so

$$D_A = .07\, R_{SECTOR} + .27 R_{ACOC} + .05 R_{STATS} + .43 R_{SATCOM}$$

Figure 5.3-12. Derivation of the ACOC Disk Load

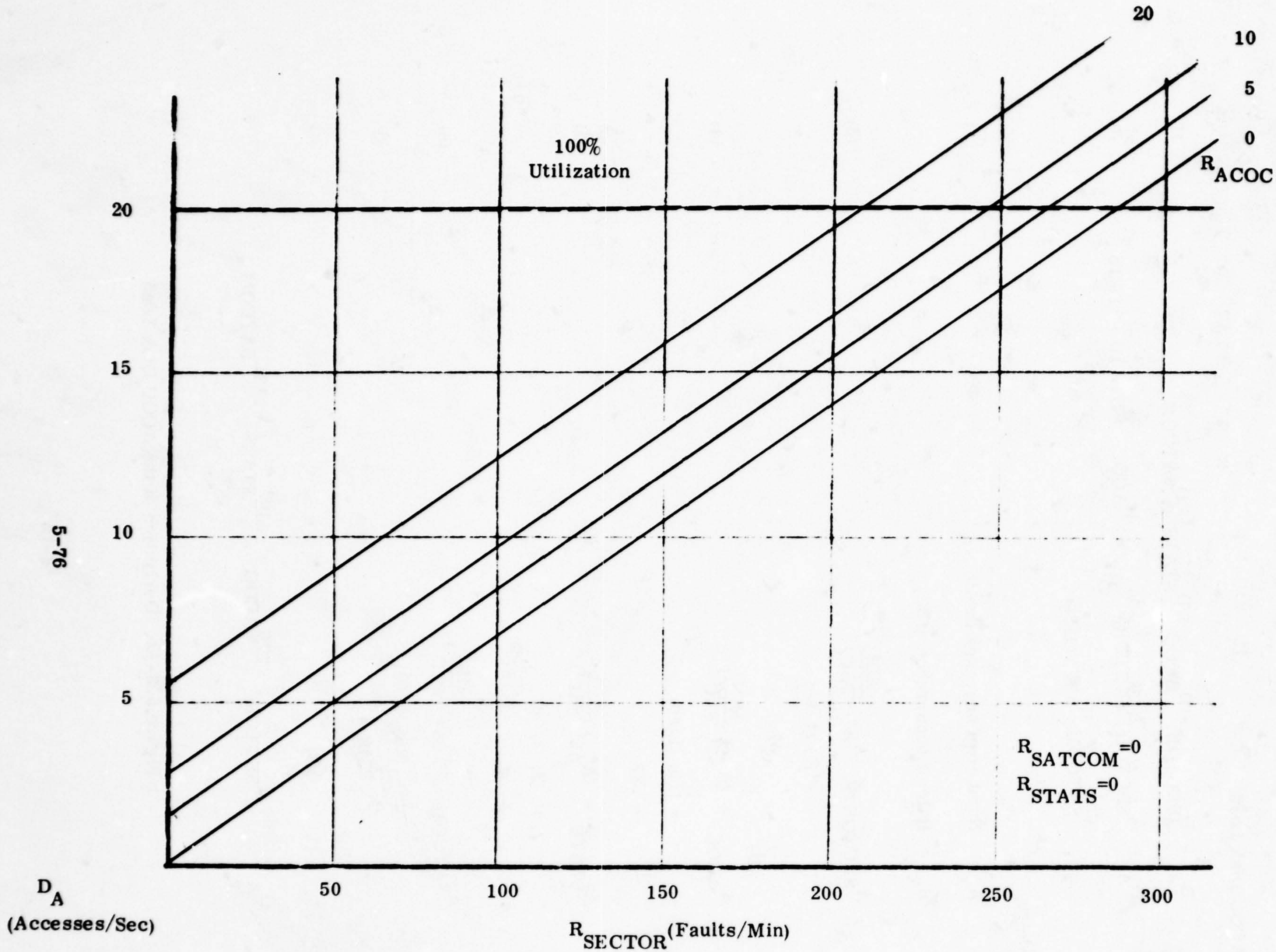


Figure 5.3-13. ACOC Disk Load ($R_{SATCOM} = 0$, $R_{STATS} = 0$) (Sheet 1 of 2)

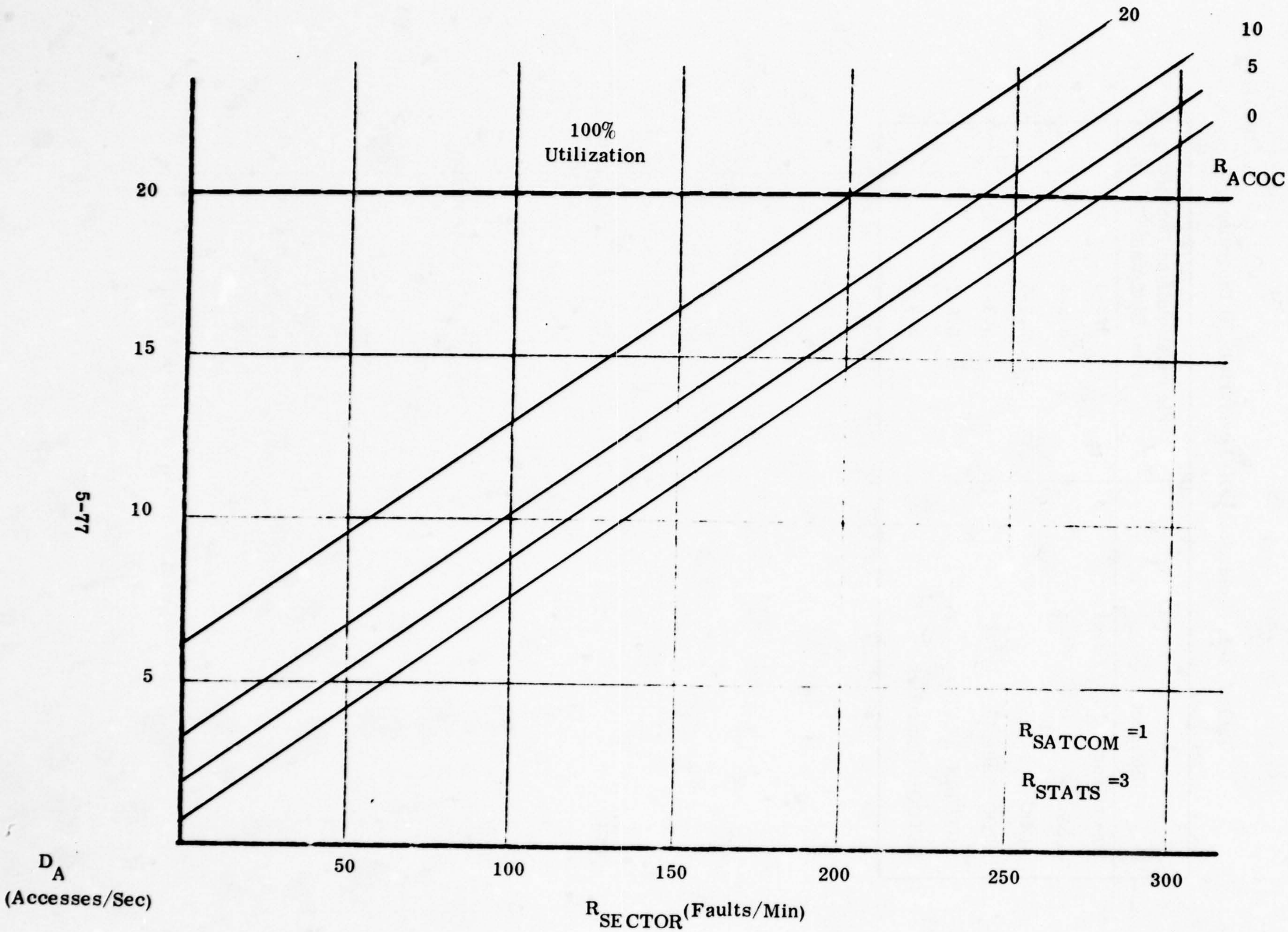


Figure 5.3-13. ACOC Disk Load (R_{SATCOM} = 1, R_{STATS} = 3) (Sheet 2 of 2)

Table 5.3-1. Guide to ACOC Level THREAD Diagrams

Element	Figure Containing Detailed Flow Diagrams
Supervisor and I/O Level	5.3-3
Sector	5.3-4
ACOC	5.3-5
ACOC Controller	5.3-6
AUTODIN (STATS)	5.3-7
SATCOM Controller	5.3-8

Table 5.3-2. ACOC Sizing Summary (Sheet 1 of 4)

PROGRAM NAME	FUNCTION	# INST HOL	PROG OCCUPANCY (Bytes)	DATA OCCUPANCY (Bytes)	COMMON	ACOC CONT	SECTOR	ACOC	DIN STATS	SATCOM				
ACOC Supervisor	Controls all scheduled software activities	300	4500		X									
Sector I O Driver	Performs sector line handling	100	1500	1000	X									
ACOC I O Driver	Performs ACOC line handling	100	1500	1000	X									
CRT I O Driver	Performs CRT line handling	200	3000	2000	X									
STATS I O Driver	Performs STATS line handling	75	1125	160	X									
Sector Message Processor	Performs preliminary message processing of sector input	50	750				X							
ACOC Message Processor	Performs preliminary message processing of ACOC input	50	750					X						
ACOC Controller Message Processor	Performs preliminary message processing of ACOC controller input	50	750			X								
STATS Message Processor	Performs preliminary message processing of STATS input	50	750						X					
SATCOM Message Processor	Performs preliminary message processing of SATCOM input	50	750							X				
Journal Inspection Processor	Controls retrieval of journal data for operator inspection	275	4125			X								
Fault Notification Broadcast Processor	Supervises processing of fault notifications at the ACOC	250	3750		X									
Fault Update Broadcast Processor	Supervises processing of fault updates at the ACOC	250	3750		X									
Fault Closure Broadcast Processor	Supervises processing of fault closures at the ACOC	250	3750		X									
Broadcast Message Generator	Formats a broadcast message	100	1500							X				
Fault Summary Processor	Supervises summarization of outstanding faults	150	2250		X									
Fault Record Retrieve	Supervises retrieval of detailed fault records for controller display	50	750		X									
ACOC Fault Retrieval Processor	Supervises retrieval of detailed fault records for other ACOCs	75	1125					X						
ACOC Fault Destination Processor	Supervises routing of detailed fault data to requesting position	50	750					X						
Connectivity Display Processor	Supervises retrieval and display of connectivity data	200	3000			X								
Connectivity Modification Processor	Supervises modification of connectivity	500	7500		X									
Network Modification Processor	Supervises acceptance of controller directed network modifications	75	1125			X								
Reroute Directive Processor	Supervises acceptance of controller directed reroute actions	100	1500			X								
Reroute Authorization Processor	Accepts controller authorization for request reroute actions	50	750			X								
Reroute Confirmation Processor	Supervises data base update upon confirmation receipt from sector	200	3000		X									
Media Status Retrieval Processor	Supervises retrieval of media status for a controller or ACOC	250	3750		X									
PMP QA Measurement Processor	Schedules journaling of PMP QA data	50	750				X							
Free Text Message Processor	Supervises routing display of free text messages	50	750		X									
SATCOM Fault Accept	Supervises acceptance of SATCOM controller generated faults	75	1125							X				

Table 5.3-2. ACOC Sizing Summary (Sheet 2 of 4)

PROGRAM NAME	FUNCTION	# INST HOL	PROG OCCUPANCY (Bytes)	DATA OCCUPANCY (Bytes)	COMMON	ACOC CONT	SECTOR	ACOC	DIN STATS	SATCOM
SATCOM Fault Update	Supervises updates of SATCOM controller faults	100	1500							X
SATCOM Fault Close	Supervises closure processing of SATCOM controller faults	100	1500							X
Traffic Control Processor	Accept ACOC controller traffic control directives	100	1500			X				
STATS Summary Processor	Supervise data base updates upon receipt of DIN traffic data	50	750						X	
AUTOVON Traffic Processor	Accepts AUTOVON traffic data	300	4500				X			
AUTOVON Station Equipment Processor	Supervises data base update upon receipt of AUTOVON switch status	50	750				X			
AUTODIN Station Equipment Processor	Supervises data base update upon receipt of AUTODIN switch status	50	750				X			
AUTOSEVOCOM Station Equipment Processor	Supervises data base update upon receipt of AUTOSEVOCOM switch status	50	750				X			
Link Connectivity Retrieve	Performs link connectivity retrieval from media files	50	750		X					
VFCT Trunk Connectivity Retrieve	Performs VFCT trunk connectivity retrieval from media files	200	3000		X					
Trunk Connectivity Retrieve	Performs trunk connectivity retrieval from media files	100	1500		X					
CCSD Connectivity Retrieve	Performs CCSD connectivity retrieval from media files	200	3000		X					
Link Connectivity Update	Performs link connectivity update in media files	100	1500		X					
VFCT Trunk Connectivity Update	Performs VFCT trunk connectivity update in media files	400	6000		X					
Trunk Connectivity Update	Performs trunk connectivity update in media files	200	3000		X					
CCSD Connectivity Update	Performs CCSD connectivity update in media files	400	6000		X					
Station Equipment Update	Performs station equipment file updates	100	1500			X				
Switch Equipment Update	Performs switch equipment file updates	100	1500			X				
Precedence Determine	Determines precedence of a reported fault	400	6000		X					
Destination Processor	Determines routing for unified control messages	50	750		X					
Terminating Sector Determine	Determines the sector with jurisdiction over the terminating station for a circuit, trunk, or link	50	750		X					
Destination Sector Determine	Determines all sectors with jurisdiction over a given circuit, trunk, or link	150	2250		X					
Fault File Manager	Provides all access to the fault file	150	2250		X					
Fault Summary Generator	Formats a fault summary line	50	750		X					
Control Action Log Manager	Manages the Traffic Control Action Log	150	2250			X				
Journal Output Manager	Controls all output to the journal	50	750		X					
Connectivity Mod Syntax Check	Performs syntax validation of controller connectivity modifications	100	1500			X				
CRT Output Buffer Manager	Controls all scheduled output to the controller positions	200	3000		X					

Table 5.3-2. ACOC Sizing Summary (Sheet 3 of 4)

PROGRAM NAME	FUNCTION	# INST HOL	PROG OCCUPANCY (Bytes)	DATA OCCUPANCY (Bytes)	COMMON	ACOC CONT	SECTOR	ACOC	DIN STATS	SATCOM
DIN Traffic Threshold Check	Examines TATS Traffic Summary Messages for queue length thresholds	50	750						X	
VON Traffic Data Correlation Processor	Examines VON traffic summary messages for efficiency thresholds	750	11250				X			
AUTOVON Traffic Display Processor	Formats VON traffic summaries and displays	300	4500			X				
AUTODIN Traffic Display Processor	Formats DIN traffic summaries and displays	50	750			X				
AUTOVON Switch Equipment Status Retrieve	Retrieves VON switch equipment status	50	750			X				
AUTODIN Switch Equipment Status Retrieve	Retrieves DIN switch equipment status	50	750			X				
AUTOSEVOCOM Switch Equip Status Retrieve	Retrieves SEVOCOM switch equipment status	50	750			X				
Station File Manager	Provides all access to the station file	175	2625		X					
Link File Manager	Provides all access to the link file	175	2625		X					
Trunk File Manager	Provides all access to the trunk file	150	2250		X					
VFCT Trunk Manager	Provides access to VFCT trunk data	175	2625		X					
CCSD File Manager	Provides all access to the CCSD file	200	3000		X					
Journal Input Manager	Processes all data into the journal	175	2625		X					
Journal Display Formatter	Formats data retrieved from the journal for display	100	1500			X				
Communications Message Formatter	Formats messages for data link transmission	150	2250		X					
Display File Manager	Performs retrieval of standard system displays	50	750		X					
Display Generator	Parametrically builds system screen displays	50	750	300	X					
Fault File Search	Performs keyed searches of the fault file	75	1125		X					
Fault File Linkage Modification	Maintains fault file linkage integrity	150	2250		X					
Fault Filter	Applies selection filters on fault data for summary presentation	50	750		X					
Related Fault Record Manager	Maintains related fault record linkage	50	750		X					
AUTOVON Detail File Manager	Provides access to the AUTOVON Detail File	100	1500		X					
AUTODIN Detail File Manager	Provides access to the AUTODIN Detail File	100	1500		X					
AUTOSEVOCOM Detail File Manager	Provide access to the AUTOSEVOCOM Detail File	100	1500		X					
ACOC Controller Decode Valid.	Performs message type determination and validation	100	1500			X				
SATCOM Controller Decode Valid	Performs message type determination and validation	75	1125							X
Message Type Decode	Performs communications message type determination	175	2625		X					
I O Error Processor	Performs recovery processing upon communication error detection	150	2250		X					
Journal Block Formatter	Builds blocks of data for output to the journal	150	2250		X					

Table 5.3-2. ACOC Sizing Summary (Sheet 4 of 4)

PROGRAM NAME	FUNCTION	# INST HOL	PROG OCCUPANCY (Bytes)	DATA OCCUPANCY (Bytes)	COMMON	ACOC CONT	SECTOR	ACOC	DIN STATS	SATCOM				
Communications Buffer Manager	Maintains the data link I/O buffers	100	1500		X									
Communications Message File Manager	Performs retrieval of standard system communications messages	50	750		X									
CRT Buffer Manager	Maintains the CRT input buffers	75	1125		X									
STATS Buffer Manager	Maintains the STATS input buffer	50	750		X									
FIND	Performs generic data base maintenance processing	500	7500		X									
GET	Performs generic data base maintenance processing	500	7500		X									
CREATE	Performs generic data base maintenance processing	500	7500		X									
DELETE	Performs generic data base maintenance processing	500	7500		X									
MODIFY	Performs generic data base maintenance processing	500	7500		X									
	Total Lines of Code - 14,875													
	Total Program Occupancy - 223,125 bytes													
	Total Data Occupancy - 4,460 bytes													

Table 5.3-3. ACOC Resident and Support Overlay Sizing Summary (Sheet 1 of 2)

PROGRAM NAME	FUNCTION	# Inst HOL	Prog Occupancy (Bytes)	Data Occupancy (Bytes)	Resident	ACOC Cont Support	Section Support	ACOC Support	DIN STATS	SATCOM
ACOC Supervisor	Controls all scheduled software activities	300	4500		X					
Sector I/O Driver	Performs sector line handling	100	1500	1000	X					
ACOC I/O Driver	Performs ACOC line handling	100	1500	1000	X					
CRT I/O Driver	Performs CRT line handling	200	3000	2000	X					
STATS I/O Driver	Performs STATS line handling	75	1125	160	X					
Sector Message Processor	Performs preliminary message processing of sector input	50	750				X			
ACOC Message Processor	Performs preliminary message processing of ACOC input	50	750					X		
ACOC Controller Message Processor	Performs preliminary message processing of ACOC controller input	50	750			X				
STATS Message Processor	Performs preliminary message processing of STATS input	50	750						X	
SATCOM Message Processor	Performs preliminary message processing of SATCOM input	50	750							X
Broadcast Message Generator	Formats a broadcast message	100	1500							X
Fault Summary Processor	Supervises summarization of outstanding faults	150	2250							X
Fault Record Retrieve	Supervises retrieval of detailed fault records for controller display	50	750							X
Media Status Retrieval Processor	Supervises retrieval of media status for a controller or ACOC	250	3750							X
Free Text Message Processor	Supervises routing/display of free text messages	50	750							X
STATS Summary Processor	Supervises data base updates upon receipt of DIN traffic data	50	750						X	
SATCOM Fault Accept	Supervises acceptance of SATCOM controller generated faults	75	1125							X
SATCOM Fault Update	Supervises updates of SATCOM controller faults	100	1500							X
SATCOM Fault Close	Supervises closure processing of SATCOM controller faults	100	1500							X
Precedence Determine	Determines precedence of a reported fault	400	6000							X
Destination Processor	Determines routing for unified control messages	50	750			X	X	X		
Terminating Sector Determine	Determines the sector with jurisdiction over the terminating station for a circuit, trunk or link	50	75			X		X		X
Destination Sector Determine	Determines all sectors with jurisdiction over a given circuit, trunk or link	150	2250			X	X	X		X
Fault File Manager	Provides all access to the fault file	150	2250							X
Fault Summary Generator	Formats a fault summary line	50	750							X
Control Action Log Manager	Manages the Traffic Control Action Log	150	2250			X				
CRT Output Buffer Manager	Controls all scheduled output to the controller positions	200	3000			X	X	X		X
DIN Traffic Threshold Check	Examines STATS Traffic Summary Messages for queue length thresholds	50	750							X
Station File Manager	Provides all access to the station file	175	2625			X	X	X		X

Table 5.3-3. ACOC Resident and Support Overlay Sizing Summary (Sheet 2 of 2)

PROGRAM NAME	FUNCTION	# Inst HOL	Prog Occupancy (Bytes)	Data Occupancy (Bytes)	Resident	ACOC Cont Support	Section Support	ACOC Support	DIN STATS	SATCOM
Link File Manager	Provides all access to the link file	175	2625			X	X	X		X
Trunk File Manager	Provides all access to the trunk file	150	2250			X	X	X		X
VFCT Trunk Manager	Provides access to VFCT trunk data	175	2625			X	X	X		X
CCSD File Manager	Provides all access to the CCSD file	200	3000			X	X	X		X
Journal Input Manager	Processes all data into the journal	175	2625			X	X		X	X
Communications Message Formatter	Formats messages for data link transmission	150	2250			X	X	X		X
Display File Manager	Performs retrieval of standard system displays	50	750			X	X	X		X
Display Generator	Parametrically builds system screen displays	50	750	300		X				X
Fault File Search	Performs keyed searches of the fault file	75	1125							X
Fault File Linkage Modification	Maintains fault file linkage integrity	150	2250							X
Fault Filter	Applies selection filters on fault data for summary presentation	50	750							X
Related Fault Record Manager	Maintains related fault record linkage	50	750							X
AUTODIN Detail File Manager	Provides access to the AUTODIN Detail File	100	1500						X	
ACOC Controller Decode/Valid	Performs message type determination and validation	100	1500			X				
SATCOM Controller Decode/Valid	Performs message type determination and validation	75	1125							X
Message Type Decode	Performs communications message type determination	175	2625				X	X		
I/O Error Processor	Performs recovery processing upon communication error detection	150	2250				X	X		
Journal Block Formatter	Builds Blocks of data for output to the journal	150	2250			X	X		X	X
Communications Buffer Manager	Maintains the data link I/O buffers	100	1500				X	X		
Communications Message File Manager	Performs retrieval of standard system communications messages	50	750							X
CRT Buffer Manager	Maintains the CRT input buffers	75	1125			X				X
STATS Buffer Manager	Maintains the STATS input buffer	50	750						X	
FIND	Performs generic data base maintenance processing	500	7500			X	X	X		X
GET	Performs generic data base maintenance processing	500	7500			X	X	X		X
CREATE	Performs generic data base maintenance processing	500	7500			X	X	X		X
DELETE	Performs generic data base maintenance processing	500	7500			X	X	X		X
MODIFY	Performs generic data base maintenance processing	500	7500			X	X	X		X
TOTAL OCCUPANCY					15785	71925	71625	67500	9375	96300

Table 5.3-4. ACOC Functional Overlay Sizing Summary (Sheet 1 of 6)

PROGRAM NAME	NO. INST HOL	Program Occupancy (Bytes)	ACOC										
			Fault Notification Broadcast	Fault Update Broadcast	Fault Closure Broadcast	ACOC Fault Retrieval	ACOC Fault Destination	Connectivity Modification	Network Modification	Reroute Directive	Reroute Confirmation	Media Status Retrieval	Free Text Msg Processing
CCSD Connectivity Update	400	6000						X					
Station Equipment Update	100	1500						X					
Switch Equipment Update	100	1500						X					
Fault File Manager	150	2250											
Fault Summary Generator	50	750											
Journal Output Manager	50	750											
Connectivity Mod. Syntax Check	100	1500											
VON Traffic Data Correlation Processor	750	11250											
AUTOVON Traffic Display Processor	300	4500											
AUTODIN Traffic Display Processor	50	750											
AUTOVON Switch Equipment Status Retrieve	50	750											
AUTODIN Switch Equipment Status Retrieve	50	750											
AUTOSEVOCOM Switch Equip Status Retrieve	50	750											
Journal Display Formatter	100	1500											
Fault File Search	75	1125											
Fault File Linkage Modification	150	2250											
Fault Filter	50	750											
Related Fault Record Manager	50	750											
AUTOVON Detail File Manager	100	1500											
AUTODIN Detail File Manager	100	1500											
AUTOSEVOCOM Detail File Manager	100	1500											
Total Occupancy			3750	3750	3750	1125	750	27000	1125	1500	3000	3750	750

Table 5.3-4. ACOC Functional Overlay Sizing Summary (Sheet 2 of 6)

			ACOC																
PROGRAM NAME	NO. INST HOL	Program Occupancy (Bytes)	Fault Notification Broadcast	Fault Update Broadcast	Fault Closure Broadcast	ACOC Fault Retrieval	ACOC Fault Destination	Connectivity Modification	Network Modification	Reroute Directive	Reroute Confirmation	Media Status Retrieval	Free Text Msg Processing						
Journal Inspection Processor	275	4125																	
Fault Notification Broadcast Processor	250	3750	X																
Fault Update Broadcast Processor	250	3750		X															
Fault Closure Broadcast Processor	250	3750			X														
Fault Summary Processor	150	2250																	
Fault Record Retrieve	50	750																	
ACOC Fault Retrieval Processor	75	1125				X													
ACOC Fault Destination Processor	50	750					X												
Connectivity Display Processor	200	3000																	
Connectivity Modification Processor	500	7500						X											
Network Modification Processor	75	1125							X										
Reroute Directive Processor	100	1500								X									
Reroute Authorization Processor	50	750																	
Reroute Confirmation Processor	200	3000									X								
Media Status Retrieval Processor	250	3750										X							
PMP/QA Measurement Processor	50	750																	
Free Text Message Processor	50	750											X						
Traffic Control Processor	100	1500																	
AUTOVON Traffic Processor	300	4500																	
AUTOVON Station Equipment Processor	50	750																	
AUTODIN Station Equipment Processor	50	750																	
AUTOSEVOCOM Station Equipment Processor	50	750																	
Link Connectivity Retrieve	50	750																	
VFCT Trunk Connectivity Retrieve	200	3000																	
Trunk Connectivity Retrieve	100	1500																	
CCSD Connectivity Retrieve	200	3000																	
Link Connectivity Update	100	1500						X											
VFCT Trunk Connectivity Update	400	6000						X											
Trunk Connectivity Update	200	3000						X											

Table 5.3-4. ACOC Functional Overlay Sizing Summary (Sheet 3 of 6)

			SECTOR																	
PROGRAM NAME	NO. INST HOL	Program Occupancy (Bytes)	Fault Notification Broadcast	Fault Update Broadcast	Fault Closure Broadcast	Connectivity Modification	Reroute Directive	Reroute Authorization	Reroute Confirmation	PMP QA Measurements	Detailed Fault Reports	Free Text Msg Processing	AUTOVON Traffic Processor	AUTOVON Station Equip	AUTODIN Station Equipment	AUTOSEVOCOM Station Equipment					
Journal Inspection Processor	275	4125																			
Fault Notification Broadcast Processor	250	3750	X																		
Fault Update Broadcast Processor	250	3750		X																	
Fault Closure Broadcast Processor	250	3750			X																
Fault Summary Processor	150	2250																			
Fault Record Retrieve	50	750																			
ACOC Fault Retrieval Processor	75	1125																			
ACOC Fault Destination Processor	50	750																			
Connectivity Display Processor	200	3000																			
Connectivity Modification Processor	500	7500				X															
Network Modification Processor	75	1125																			
Reroute Directive Processor	100	1500					X														
Reroute Authorization Processor	50	750						X													
Reroute Confirmation Processor	200	3000							X												
Media Status Retrieval Processor	250	3750																			
PMP/QA Measurement Processor	50	750								X											
Free Text Message Processor	50	750										X									
Traffic Control Processor	100	1500																			
AUTOVON Traffic Processor	300	4500											X								
AUTOVON Station Equipment Processor	50	750												X							
AUTODIN Station Equipment Processor	50	750													X						
AUTOSEVOCOM Station Equipment Processor	50	750														X					
Link Connectivity Retrieve	50	750																			
VFCT Trunk Connectivity Retrieve	200	3000																			
Trunk Connectivity Retrieve	100	1500																			
CCSD Connectivity Retrieve	200	3000																			
Link Connectivity Update	100	1500				X															
VFCT Trunk Connectivity Update	400	6000				X															
Trunk Connectivity Update	200	3000				X															

Table 5.3-4. ACOC Functional Overlay Sizing Summary (Sheet 4 of 6)

PROGRAM NAME	NO. INST HOL	Program Occupancy (Bytes)	SECTOR: Fault Notification Broadcast	Fault Update Broadcast	Fault Closure Broadcast	Connectivity Modification	Reroute Directive	Reroute Authorization	Reroute Confirmation	PMP QA Measurements	Detailed Fault Reports	Free Text Msg Processing	AUTOVON Traffic Processor	AUTOVON Station Equip	AUTODIN Station Equip	AUTOSEVOCOM Station Equip
CCSD Connectivity Update	400	6000				X										
Station Equipment Update	100	1500				X										
Switch Equipment Update	100	1500				X										
Fault File Manager	150	2250						X		X						
Fault Summary Generator	50	750														
Journal Output Manager	50	750														
Connectivity Mod. Syntax Check	100	1500														
VON Traffic Data Correlation Processor	750	11250											X			
AUTOVON Traffic Display Processor	300	4500														
AUTODIN Traffic Display Processor	50	750														
AUTOVON Switch Equipment Status Retrieve	50	750														
AUTODIN Switch Equipment Status Retrieve	50	750														
AUTOSEVOCOM Switch Equip Status Retrieve	50	750														
Journal Display Formatter	100	1500														
Fault File Search	75	1125														
Fault File Linkage Modification	150	2250									X					
Fault Filter	50	750														
Related Fault Record Manager	50	750														
AUTOVON Detail File Manager	100	1500											X			
AUTODIN Detail File Manager	100	1500														
AUTOSEVOCOM Detail File Manager	100	1500														
Total Occupancy			3750	3750	3750	27000	1500	750	5250	750	4500	750	17250	750	750	750

Table 5.3-4. ACOC Functional Overlay Sizing Summary (Sheet 5 of 6)

PROGRAM NAME	NO. INST HOL	Program Occupancy (Bytes)	ACOC CONTROLLER																	
			Journal Inspection	Fault Summarization	Fault Record Retrieval	Connectivity Display	Network Modification	Reroute Directive	Reroute Authorization	Traffic Data Display	Media Status Retrieval	Free Text Msg Processing	Traffic Control	Switch Equip Status						
Journal Inspection Processor	275	4125	X																	
Fault Notification Broadcast Processor	250	3750																		
Fault Update Broadcast Processor	250	3750																		
Fault Closure Broadcast Processor	†250	3750																		
Fault Summary Processor	150	2250		X																
Fault Record Retrieve	50	750			X															
ACOC Fault Retrieval Processor	75	1125																		
ACOC Fault Destination Processor	50	750																		
Connectivity Display Processor	200	3000				X														
Connectivity Modification Processor	500	7500																		
Network Modification Processor	75	1125					X													
Reroute Directive Processor	100	1500						X												
Reroute Authorization Processor	50	750							X											
Reroute Confirmation Processor	200	3000																		
Media Status Retrieval Processor	250	3750									X									
PMP/QA Measurement Processor	50	750																		
Free Text Message Processor	50	750										X								
Traffic Control Processor	100	1500											X							
AUTOVON Traffic Processor	300	4500																		
AUTOVON Station Equipment Processor	50	750																		
AUTODIN Station Equipment Processor	50	750																		
AUTOSEVOCOM Station Equipment Processor	50	750																		
Link Connectivity Retrieve	50	750				X														
VFCT Trunk Connectivity Retrieve	200	3000				X														
Trunk Connectivity Retrieve	100	1500				X														
CCSD Connectivity Retrieve	200	3000				X														
Link Connectivity Update	100	1500																		
VFCT Trunk Connectivity Update	400	6000																		
Trunk Connectivity Update	200	3000																		

Table 5.3-4. ACOC Functional Overlay Sizing Summary (Sheet 6 of 6)

PROGRAM NAME	NO. INST HOL	Program Occupancy (Bytes)	ACOC CONTROLLER: Journal Inspection	Fault Summarization	Fault Record Retrieval	Connectivity Display	Network Modification	Reroute Directive	Reroute Authorization	Traffic Data Display	Media Status Retrieval	Free Text Msg Processing	Traffic Control	Switch Equipment Status
CCSD Connectivity Update	400	6000												
Station Equipment Update	100	1500												
Switch Equipment Update	100	1500												
Fault File Manager	150	2250		X	X									
Fault Summary Generator	50	750		X										
Journal Output Manager	50	750	X											
Connectivity Mod. Syntax Check	100	1500					X							
VON Traffic Data Correlation Processor	750	11250												
AUTOVON Traffic Display Processor	300	4500								X				
AUTODIN Traffic Display Processor	50	750								X				
AUTOVON Switch Equipment Retrieve Status	50	750												X
AUTODIN Switch Equipment Retrieve Status	50	750												X
AUTOSEVOCOM Switch Equip Retrieve Status	50	750												X
Journal Display Formatter	100	1500	X											
Fault File Search	75	1125		X	X									
Fault File Linkage Modification	150	2250												
Fault Filter	50	750		X										
Related Fault Record Manager	50	750		X	X									
AUTOVON Detail File Manager	100	1500								X				X
AUTODIN Detail File Manager	100	1500								X				X
AUTOSEVOCOM Detail File Manager	100	1500												X
Total Occupancy			6375	7875	4875	11250	2625	1500	750	8250	3750	750	1500	6750

Table 5.3-5. Determination of the Largest Memory Requirement for the ACOC

Element	Resident Routines	Support Overlay	Largest Functional Overlay	Total Occupancy
ACOC Controller	15,785	71,925	11,250	98,960
Sector	15,785	71,625	27,000	114,410
ACOC	15,785	67,500	27,000	110,285
DIN STATS	15,785	9,375	-	25,160
SATCOM	15,785	96,300	-	112,085

Table 5.3-6. Summary of Algorithms for the ACOC

Algorithm	Function	# ASM Inst	# Disk Accesses
A1	Process Fault Notification Broadcasts from Sectors	1005	4
A2	Process Fault Notifications from ACOCs	2475	16
A3	Process a Switch Summary Message from STATS	2500	3
A4	Request to Enter a Fault Report (SATCOM)	5445	26
A5	Retrieve and Display CCSD Connectivity for ACOC Controller	18012	16

Table 5.3-7. ACOC I/O Load

SOURCE	NO. LINES	LINE RATE (bps)	NO. BYTE TRANSFERS (B/Sec/Line)	AGGREGATE TRANSFERS/ SEC	LOAD TRANSFER (Inst)	AGGREGATE LOAD
ACOC	2 1/	2400	300	1200 1/	3	3600
SECTOR	5 1/	2400	300	3000 1/	3	9000
STATS	3	75	10	30	3	90
ACOC Cont	3	2400	300	900	3	2700
SATCOM	1	2400	300	300	3	900
TOTAL I/O LOAD - 16, 290 Inst/Sec						

1/ Full Duplex

5.4 HARDWARE CONSIDERATIONS FOR THE ACOC

In the following subsections the hardware considerations for the ACOC level of unified control including processor, peripheral equipment, and processor interface characteristics are addressed.

5.4.1 ACOC Processor

The ACOC processing system as described in Section 5.3 primarily performs data base management and display processing functions. A basic characteristic of such functions is that they are highly I/O bound by disk and terminal access requirements as demonstrated by the ACOC load analysis presented in Paragraph 5.3.3. Assuming the ACOC software to be implemented in a multi-programmed environment, a task switching overhead may be applied in a manner similar to that presented in Paragraph 3.4.1 for the Node. Using an estimate of 1 millisecond/switch the ACOC task overhead is determined to be 239 milliseconds (239 messages @ 1 millisecond/switch). The sustained ACOC load is presented for three classes of 16-bit word length minicomputers below:

8 microsecond average instruction time - 0.212
5 microsecond average instruction time - 0.134
2.5 microsecond average instruction time - 0.069

The relatively low bandwidth of processing requirements at the ACOC is apparent from this data. At these bandwidths processor speed is not a critical factor in performing real time functions. Background functions, including operator interaction, are by their nature very low bandwidth and constitute a distributable load which would not degrade real time functions.

The processor memory requirement for the ACOC is estimated to be 126K bytes (Paragraph 5.3.2). The ACOC processor should at a minimum support a memory configuration adequate to satisfy this requirement and should provide for future memory growth of 100 percent to allow for functional expansion of ACOC capabilities.

The general hardware and support software considerations discussed in Paragraph 3.4.1 for the Node apply to the ACOC level of unified control as well, due to the functional similarities between all elements of unified control.

5.4.2 ACOC Peripherals and Interfaces

Figure 5.4-1 shows the hardware configuration for the ACOC which includes a processor configured with a minimum of 128K bytes of main memory, 10M bytes of random access disk storage for data base and program overlay storage, a magnetic tape unit for long term journal retention, and as many as three KB/CRT terminals with local hard copy capabilities to support ACOC Controller positions and provide status monitor capability. Communications between the ACOC and the Sectors are provided by a total of five 2400 bps serial synchronous data channels. Two similar channels provide inter-ACOC communications.

The data base storage requirement at the ACOC is estimated to be 6.7M bytes (Section 5.2). In order to provide adequate space for applications and support software a disk capacity no less than 10M bytes should be supplied. Because of the high disk utilization at the ACOC, the average access time for the device should be less than 50 milliseconds.

The magnetic tape unit should be compatible with the Node and Sector tape units to minimize logistic and maintenance related costs. Further, the compatability would allow batch reduction of journal data to be accomplished in a single facility for the entire system.

The highly interactive nature of ACOC Controller activity requires that a powerful KB/CRT terminal be used to support this position. The required capabilities of this terminal are the same as those described for the Node terminals (Paragraph 3.4.2).

In order to provide compatability among all internal unified control communications interfaces, the synchronous channels for the ACOC should have the same capabilities as the channels described for use at the Node (Paragraph 3.4.2).

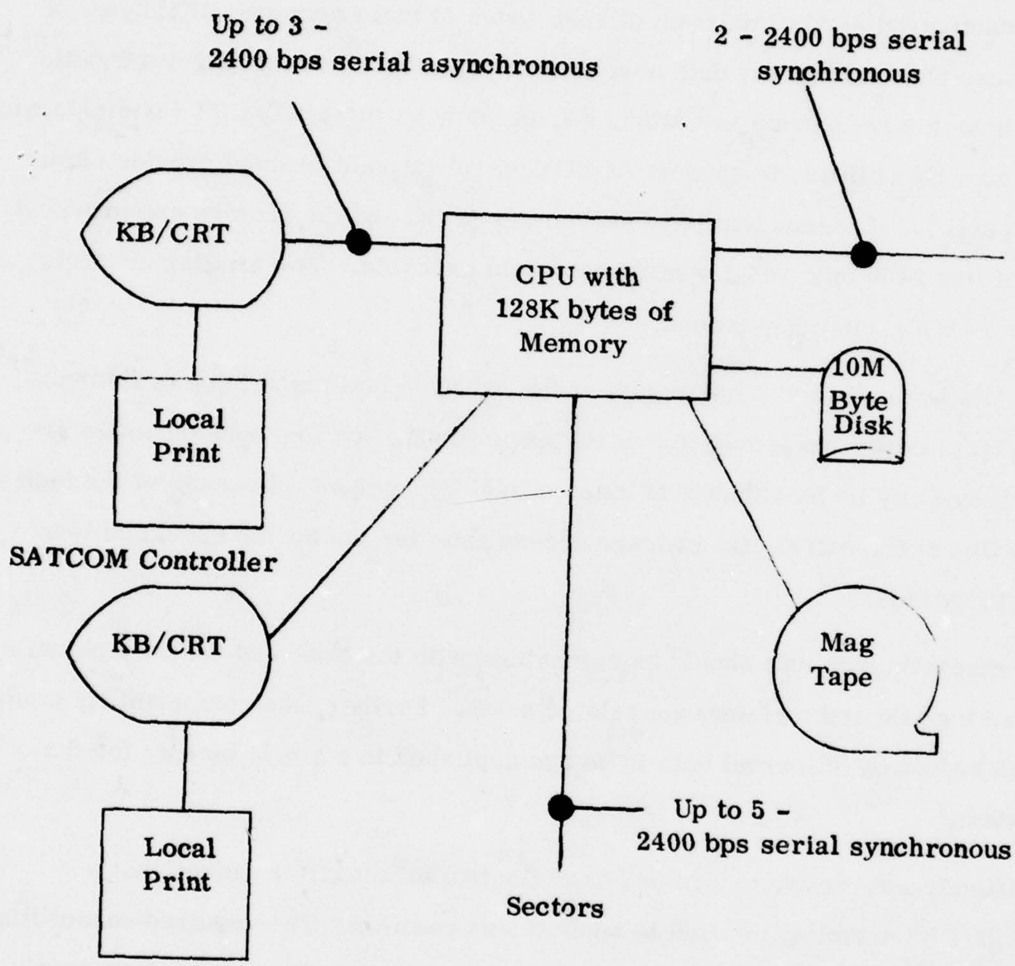


Figure 5.4-1. ACOC Hardware Configuration

SECTION 6 - AUTOVON REQUIREMENTS

6.1 GENERAL

This section treats the requirement to provide switch and network operational efficiency and traffic flow data to the ACOC Network Controller and the associated Switch Controller. This individual switch and network visibility is required if the Network Controller is to make decisions and implement controls within the switched network. The data reduction and transmission will provide displays of traffic indicators, call processing efficiency, equipment status and suggested actions to alleviate congested traffic conditions caused by overload or equipment failure.

Processing of data at station level and ACOC level are considered. For each level, the sources of data, data requirements, equipment interface, processor memory storage requirements, desired data outputs, and the algorithms necessary for output development are considered.

The base line assumptions made in the Unified Network/Traffic Transmission Media Control Interim Report, Paragraph 3.3.2.5b, that the proposed AUTOVON diagnostic processor will be installed and operational and capable of receiving other AUTOVON related data is continued in this report.

6.2 AUTOVON SWITCH STATION LEVEL MODULES

The AUTOVON Switch Station Level Module is defined as "the processing module necessary to reduce raw or partially processed inputs from AUTOVON switch equipment to a form which can be forwarded to the Node or ACOC for display or further processing".

6.2.1 Input Sources

The following paragraphs contain considerations and selection of preferred data sources.

6.2.1.1 Source Considerations

Data acquisition from the following listed sources has been considered:

a. TDCS - Output from Traffic Data Collection System (TDCS) were considered as sources for traffic conditions, line and trunk status, and equipment status.

b. ACAS - The output from AUTOVON Centralized Alarm System (ACAS) was considered as a source for equipment status and traffic overload conditions.

c. Diagnostic Processor - The Diagnostic Processor was considered as a source for equipment failure data and certain traffic overload indications.

d. TDCS Interface Buffer (IB) and Status Monitor Interface (SMI) - The AUTOVON switch interface circuits provided for TDCS and ACAS were considered as sources of call processing data, traffic overload conditions and equipment status indications.

e. Lines and Trunks - The line and trunk circuits were considered as sources for line and trunk status.

f. AUTOVON Trunk Scanner Read Buffer - The Read Buffer circuit of the AUTOVON Switch Trunk Scanner Section was considered as a source for line and trunk status.

6.2.1.2 Source Selection

Selection of recommended input sources was made on the basis of factors presented in the following subparagraphs.

6.2.1.2.1 TDCS Outputs

a. An output from an additional TDCS data port was considered for all data except equipment failure indication. This output was not considered to be feasible because of the TDCS Processor's lack of an operating system, overlay, high level language support, and the absolute assembly of the current TDCS software.

Access to TDCS data would require modification of the TDCS software principally involved with the Executive Control Program and the interrupt handling routines. The modifications to the interrupt handling routines involve incorporating the additional software drivers necessary to support continual access by the AUTOVON Switch Station level module. Additional software, normally supplied by a fully supported operating system, would need to be developed. This software would have to be resident in the unpaged region of the main memory of the TDCS processor. A major impact of this approach would be the necessity of developing all of the required additional TDCS software in assembly language, since a high order language (HOL) is not available.

b. The extraction of line, trunk, and equipment status from the CCL multiplexer output of TDCS was considered. This data source was considered impractical because TDCS must be in Traffic Data Collection Mode or Call Data Collection Mode for the CCL multiplexer output to be active. While one of the modes is frequently in use, the AUTOVON Switch Station level module will require continuous access to the status of all lines and trunks as seen by the AUTOVON switch common control.

6.2.1.2.2 ACAS Output

The serial output of ACAS was considered as a source for equipment status and traffic overload condition. The limited data available from this source did not appear to justify the use of a separate slow operating (75 baud) serial input.

6.2.1.2.3 Diagnostic Processor

The diagnostic processor as proposed in the Computer Sciences Corporation Special Study on Development of an Enhanced and Expanded 490L AUTOVON Switch Trouble Diagnostic Capability, dated February 1977, appears to be the most desirable source for equipment failure data. Correlation of certain traffic overload conditions using diagnostic processor data also appears feasible.

6.2.1.2.4 TDCS Interface Buffer (IB) and Status Monitor Interface (SMI)

a. Call Processing Data - The most logical source of call processing data is the AUTOVON Switch Register Memory. The continuously changing call processing data used by the AUTOVON switch in processing calls is now presented to TDCS from the IB circuit, and the equipment status used in TDCS and ACAS is presented for interface in the SMI circuit.

   The timing developed for Register word transmittal to TDCS can be used for interfacing to an input port of the processor containing the AUTOVON Switch Station Level Module. The outputs of the Register Word flip flops at the IDF could be paralleled using high impedance gating, or a more discrete interface could be developed by taking the Ø side outputs of the IB circuit flip flops for use in the AUTOVON Switch Station Level Module.

b. Equipment Status Leads - Those leads now interfaced to TDCS via CCL logic, but not continuously available from TDCS are available primarily in the SMI circuit. An interface for this data can be easily adapted to a standard processor input port.

6.2.1.2.5 Lines and Trunks

The status of lines and trunk circuits required for maintenance of call registers is available at the individual line and trunk circuits and would require a multiple scheme as elaborate as the TDCS CCL interface. The extensive additional hardware required for this scheme does not justify acquiring the line and trunk status.

6.2.1.2.6 AUTOVON Switch Trunk Scanner Read Buffer

Line and trunk status as seen by the AUTOVON switch is available every two seconds at the Trunk Scanner Read Buffer. This status includes all marked precedences, maintenance busy, and originating busy. The interface required to make these outputs available to a processor input port would consist of flip flop buffers, and a word available signal similar to that now provided for Register Memory in the Interface Buffer circuit.

6.2.2 Input Data

The majority of the AUTOVON switch data currently being utilized by TDCS will be useful in developing the flag, displays and decisions for relief of traffic congestion required by the network and switch controllers for effective supervision of the AUTOVON network.

6.2.2.1 Data Currently Available at Interface Points

The data currently available falls into two broad categories. They are call processing data and equipment status data.

6.2.2.1.1 Call Processing Data

The call processing data is that available through the interface buffer from the AUTOVON switch Register Memory. This data is that necessary for the measurement of all parameters surrounding the switch's handling of each call. From it, the efficiency of each switch's operation can be developed. Figure 6.2-1 shows the layout of this data as it is used in the switch and Figure 6.2-2 shows the layout and movement of these words by the AUTOVON switch and its proposed use by the AUTOVON Switch Station level module.

6.2.2.1.2 Equipment status now available at interface points includes a maximum of 1134 leads as follows:

- Out of Service Conditions for Logics, Memories, and Switch and DSA Markers (9 Leads)
- System Stop Clock and Comparator Manual Mode (2 Leads)
- Line Load Control Status (Manual Class-of-Service) (3 Leads)
- Maintenance Busy Conditions for Register Junctors (24 Leads)
- Maintenance Busy Conditions for TCMF Receivers (15 Leads)
- Maintenance Busy Conditions for MF 2/6 Transceivers (15 Leads)
- Service Busy Conditions for TCMF Receivers (15 Leads)

A B C D E F G H I J

TL	TI	AX	AD	TT		HL1	HL2	ABC	DCC	DSC	DR	OR	FD	DCX No.	MX_A	TMA	RWP 1, 9
ACC (send)	SW	ES	SK	MD	SSI	SPR	RU	IPS	IPR	DPR	IP	RX	SE	MX_B	TMB		RWP 2, 10
MF, TCMF DP(RCV) Accumulator	D8	D9	D10	P1	P2	P3	C1	C2	C3								RWP 3
MF, TCMF DP(RCV) Accumulator	Dp	Dr	D1	D2	D3	D4	D5	D6	D7								RWP 4
WPM	CPM	RE	CI	ESO	AP	ZRT	ZRU	TGT Ao	TGU Bo	TKT Co	TKU Do						RWP 5
Class of Call	CLR	PE	LO		BC		EST	LR	MS	DC		TGT At	TGU Bt	TKT Ct	TKU Dt		RWP 6
Rte Seq (t)	Rte Seq (u)	Rte No. (t)	Rte No. (u)	RDI	RSC	RNC	TGT Aso	TGU Bso	TKT Cso	TKU Dso							RWP 7
HR	HS	DT	OPR	FPT		ARC	UATG	IGT	SAT		XD						RWP 8

Figure 6.2-1. AUTOVON Switch Call Processing Data Layout

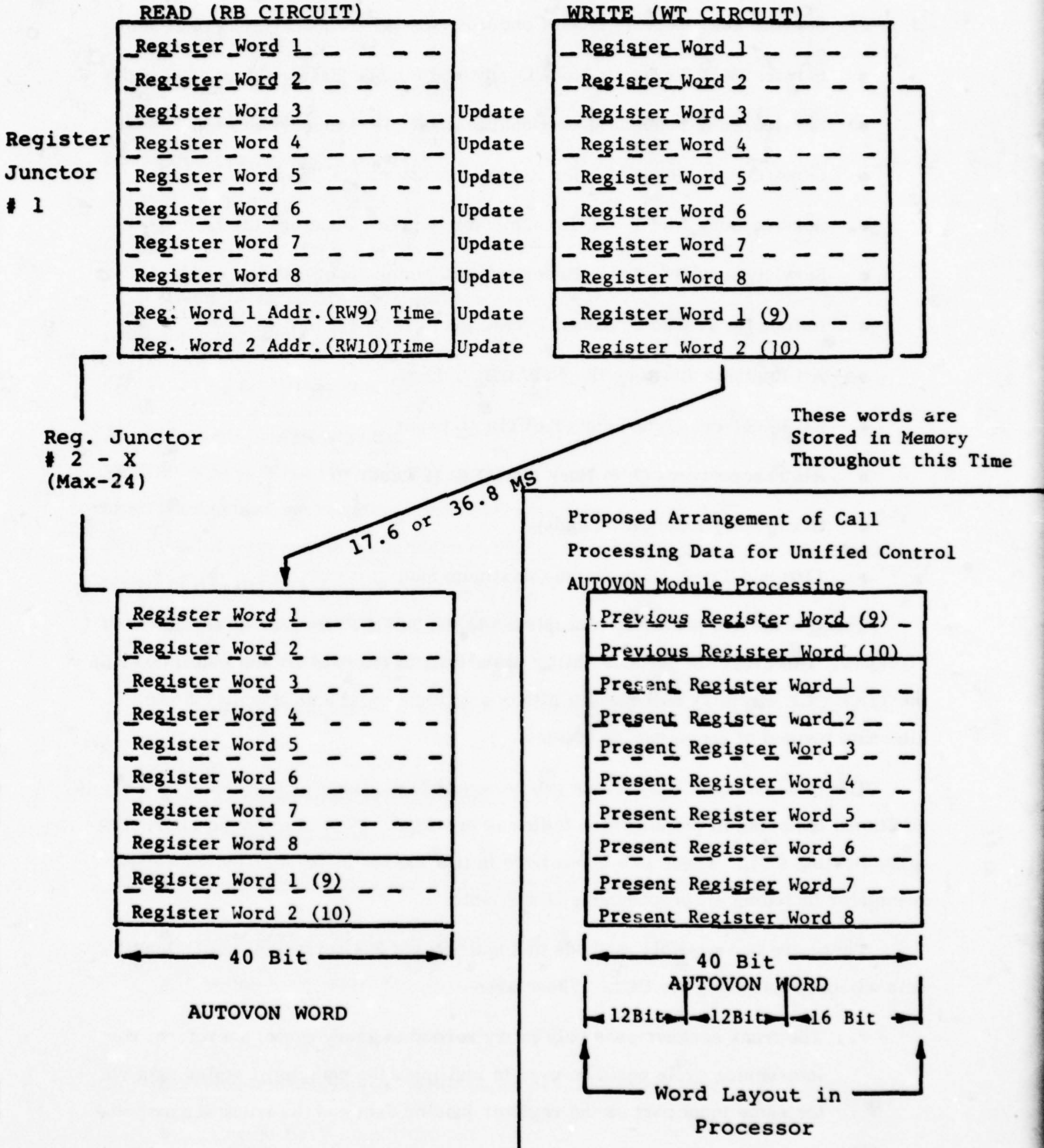


Figure 6.2-2. Layout and Movement of AUTOVON Call Processing Data Between the AUTOVON Switch and Unified Control AUTOVON Module

- Service Busy Receive Mode Conditions for MF Transceivers (15 Leads)
- Service Busy Transmit Mode Conditions for MF Transceivers (15 Leads)
- Service Busy Tandem Mode Conditions for MF Transceivers (15 Leads)
- Service Busy Conditions for Register Junctors (24 Leads)
- Service Busy Dial Pulse Transmit for Register Junctors (24 Leads)
- Service Busy Dial Pulse Receive for Register Junctors (24 Leads)
- Automatic Traffic Overload Protection (ATOP) (1Lead)
- All Register Junctors Busy (TARB) (1 Lead)
- All Receivers (2/8) Busy (TATTB) (1 Lead)
- All Transceivers (2/6) Busy (TAMFB) (1 Lead)
- Group Busy Leads (30 Leads)
- Line and Trunk Busy Status (Maximum 900)

These leads are presently multiplexed to the TDCS Processor by the TDCS CCL circuitry. However, the inaccessibility of the bulk of the data via the multiplexer of the TDCS CCL circuitry will require either a duplication of that circuitry or an alternate method of acquiring the status.

The line and trunk busy status can be acquired via the Trunk Scanner memory if additional buffering in the Interface Buffer is provided. This is a simple alternative to duplicating CCL. There is a bonus here in that the status as seen by the switch translator including all precedences is available.

There are two possible methods of acquiring the 234 equipment status leads data without duplicating the CCL. These are:

a. The trunk scanner uses only every second memory cycle, therefore, the intervening cycle could be used to multiplex the equipment status data via the same input port as the register junctor data and the trunk scanner line

and trunk status. This would require multiplexing an additional eight sets of data at two processor words per set, or a complete scan of all equipment status every 2.56 milliseconds. Figure 6.2-3 is a chart of AUTOVON switch timing showing the timing relationship between data now provided to TDCS and additional data from trunk scanner memory.

b. All except 68 of the 234 status leads can be developed from data contained in register memory and trunk scanner busy idle status. A simpler multiplex scheme would result from using this method at the cost of a more involved program in the AUTOVON processor module. The 68 required leads could be multiplexed during alternate trunk scanner memory cycles as three sets of data. The time required to scan the 68 equipment status items once would be 960 microseconds. The remaining 166 items could be developed on an as required basis by the AUTOVON processor module, or could be cyclically developed and stored regularly by the program.

Either of the approaches outlined in a and b will provide a large equipment cost saving because the TDCS CCL would not have to be duplicated. The reduction in sample leads to a manageable number also reduces the potential for failure of interface components.

The timing requirements can be reduced to the input from AUTOVON of seven processor words every 160 microseconds. This is within the I/O capability of one I/O port of most miniprocessors currently available.

6.2.3 Interface Design Requirements

The interface design requirements consists of two separate phases, data currently available and data that can be obtained by expansion of the Traffic Data Collection System (TDCS) Interface Buffer IB circuit.

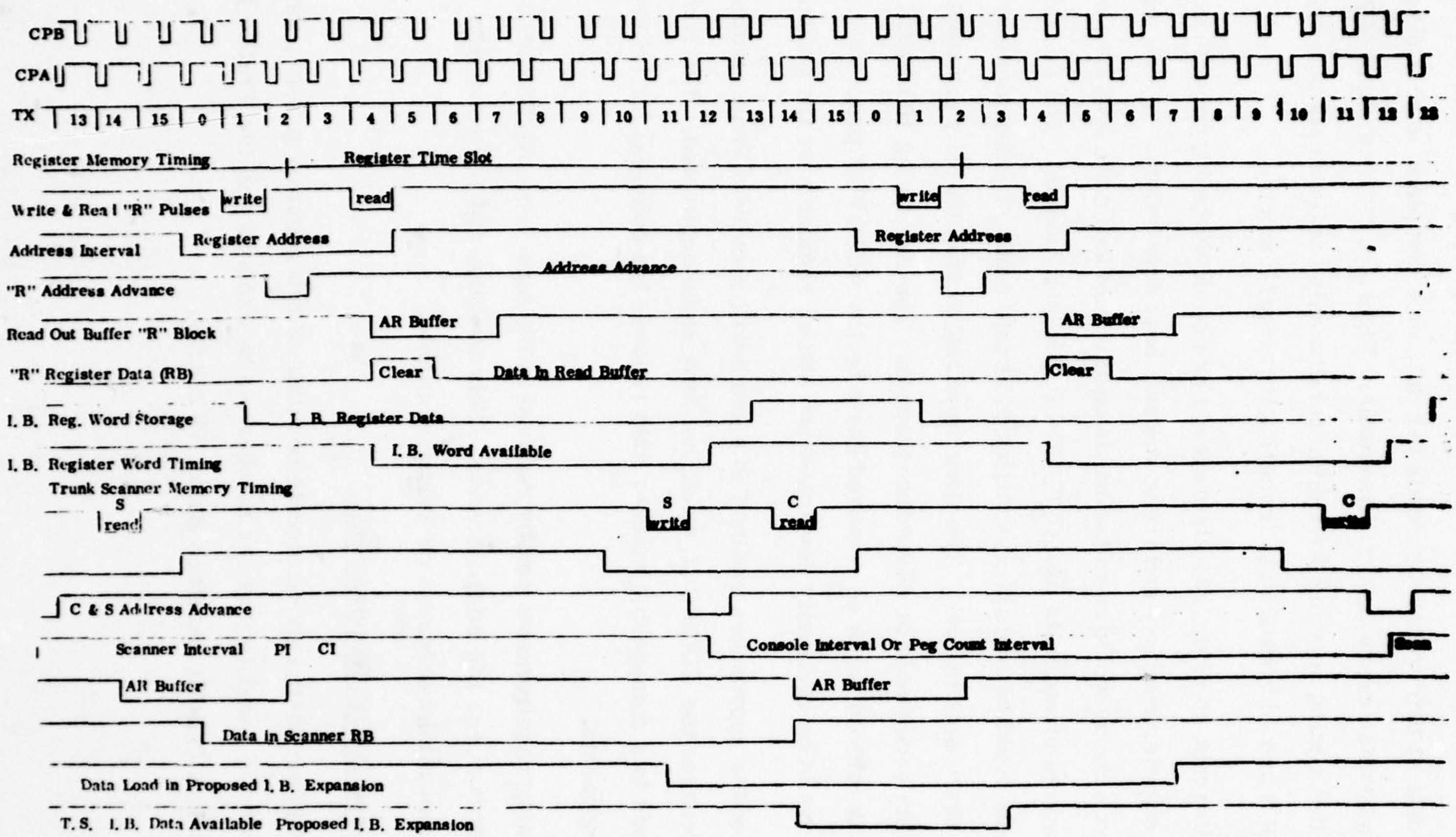


Figure 6.2-3. AUTOVON Switch Register/Trunk Scanner Memory Timing

6.2.3.1 Current Data Interface

The current data available consists of AUTOVON switch register memory (scratch pad) contents during call processing and AUTOVON switch equipment status leads.

6.2.3.1.1 AUTOVON Switch Register Memory

The register memory contents can be obtained via the Traffic Data Collection System IB circuit. The data from register memory consists of ten words, 49 bits in length of which 9 bits can be used to provide register junctor and individual word numbers. The other 40 bits of each word provides a running status of the call being processed by a particular register junctor. The output of the IB circuit can then be buffered and routed to level converter circuits before being presented to multiplexer circuits for separation into processor words, 16 bits in length. A functional block diagram of the register interface is shown in Figure 6.2-4.

6.2.3.1.2 AUTOVON Switch Equipment Status

The equipment status can be obtained from the AUTOVON Switch Status Monitor Interface (SMI) circuit. The data available from the SMI circuit consists of 234 equipment status conditions. The proposed outputs of the SMI circuit will have to be isolated from the ACAS and TDCS outputs by correed drivers or high impedance circuits. The status lead conditions will then have to be routed through level converters before being presented to multiplexer circuits for separation into processor words, 16 bits in length. A functional block diagram of the equipment status interface is shown in Figure 6.2-5.

6.2.3.2 Additional Interface Requirements

An interface to the AUTOVON Switch Read Buffer and Address Generator (trunk scanner sections) circuits is required to provide the AUTOVON Switch Station Level module with information to maintain an up-to-date status of each line or trunk circuit. The interface will consist of: expansion of the TDCS IB circuit by the addition of 55 flip flops (FF's), level converter and multiplexer circuits. A total of

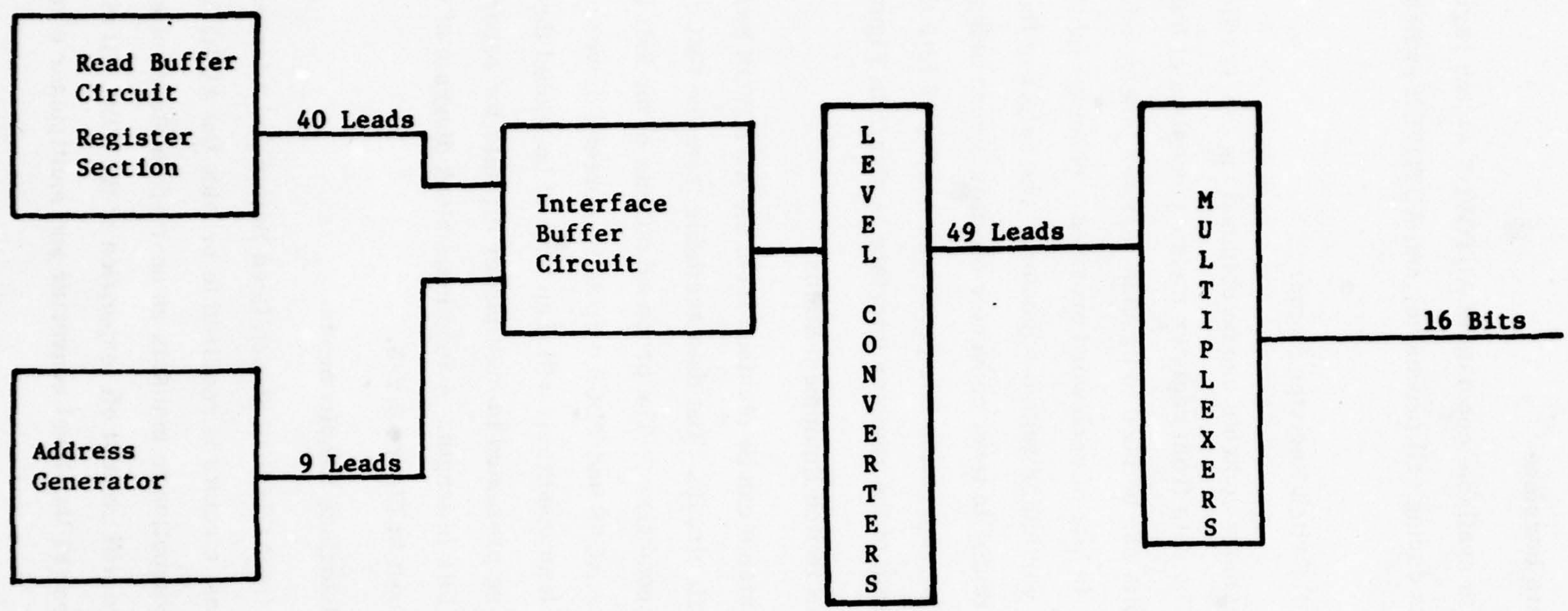


Figure 6.2-4. Register Interface Functional Diagram

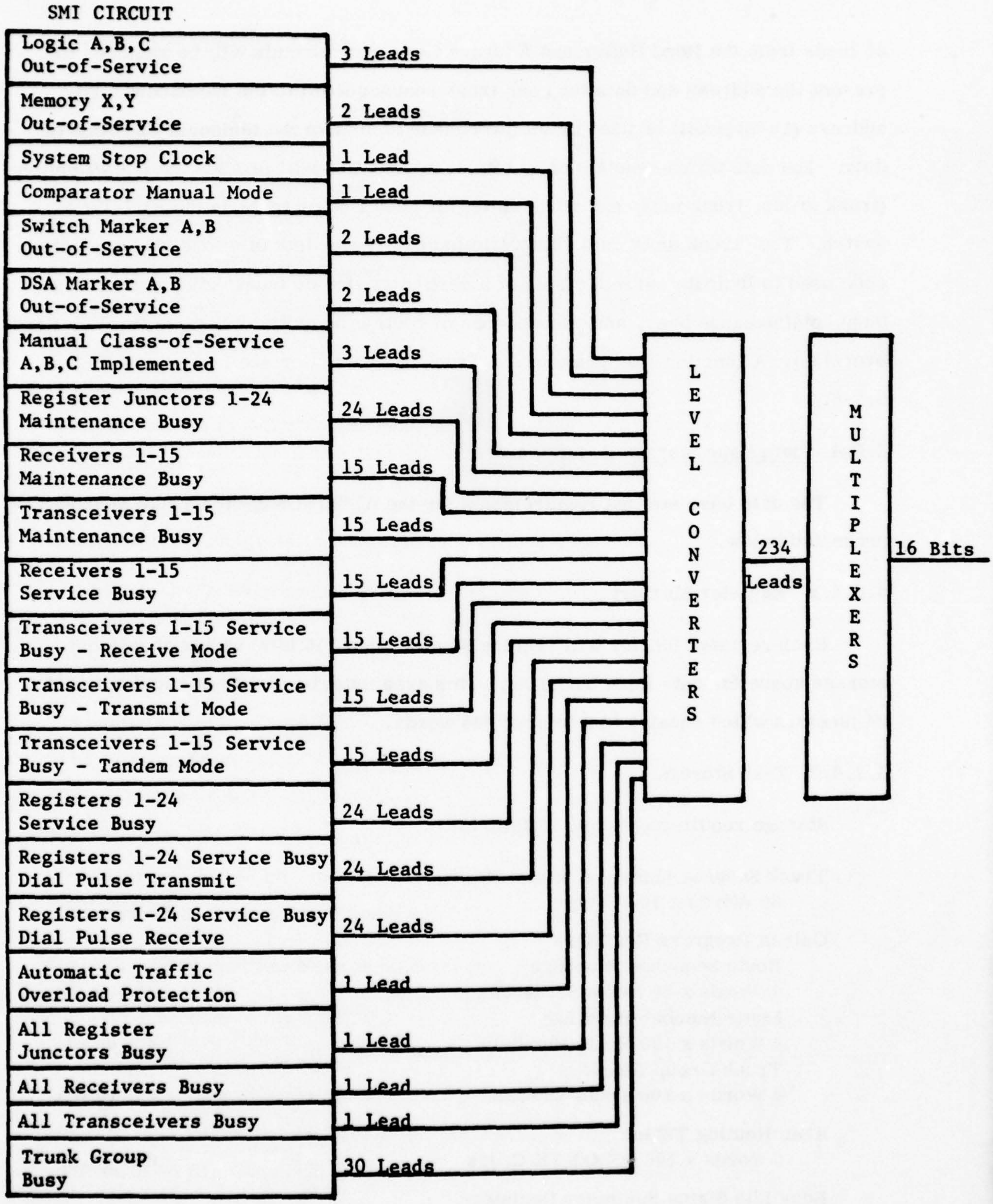


Figure 6.2-5. Equipment Status Interface Functional Diagram

55 leads from the Read Buffer and Address Generator circuits will be required to present the address and data for each trunk scanner word to the IB circuit. The address (15 bits) will be used by the processor to control the temporary storage of data. The data which consists of 40 bits of information will provide the identification (trunk group, trunk tens, and trunk units) for each line or trunk in the AUTOVON switch. The "trunk unit" data (Busy Idle Indicator) consists of a four bit hexadecimal code used to indicate current status of a particular line or trunk (idle, originating busy, maintenance busy, and precedences of routine priority immediate flash or flash override). A functional diagram of the Trunk Scanner Interface is shown in Figure 6.2-6.

6.2.4 Data Base Storage Requirements

The data base storage requirements for the AUTOVON Switch Level module are presented below.

6.2.4.1 Register Memory

Each register junctor will require 31 processor (16 bits) words of memory storage space for data input buffering. This area must be sized for a maximum of 24 junctors which equates to a total of 744 words.

6.2.4.2 Disk Storage

Storage requirements are as follows:

Trunk Scanner (Line and Trunk Status)	
30 Words x 100 Groups	3,300 words
Call in Progress Registers	
Route Sequence Blockage	
4 Words x 30 Route Sequences	120 words
Route Number Blockage	
4 Words x 100 Route Numbers	400 words
Trunk Group Blockage	
4 Words x 100 Trunk Groups	400 words
Area Routing Tables	
6 words x 100 NNX/NYX Codes	600 words
Busy Idle Status Summary Registers	
2 words x 100 Trunk Groups	200 words

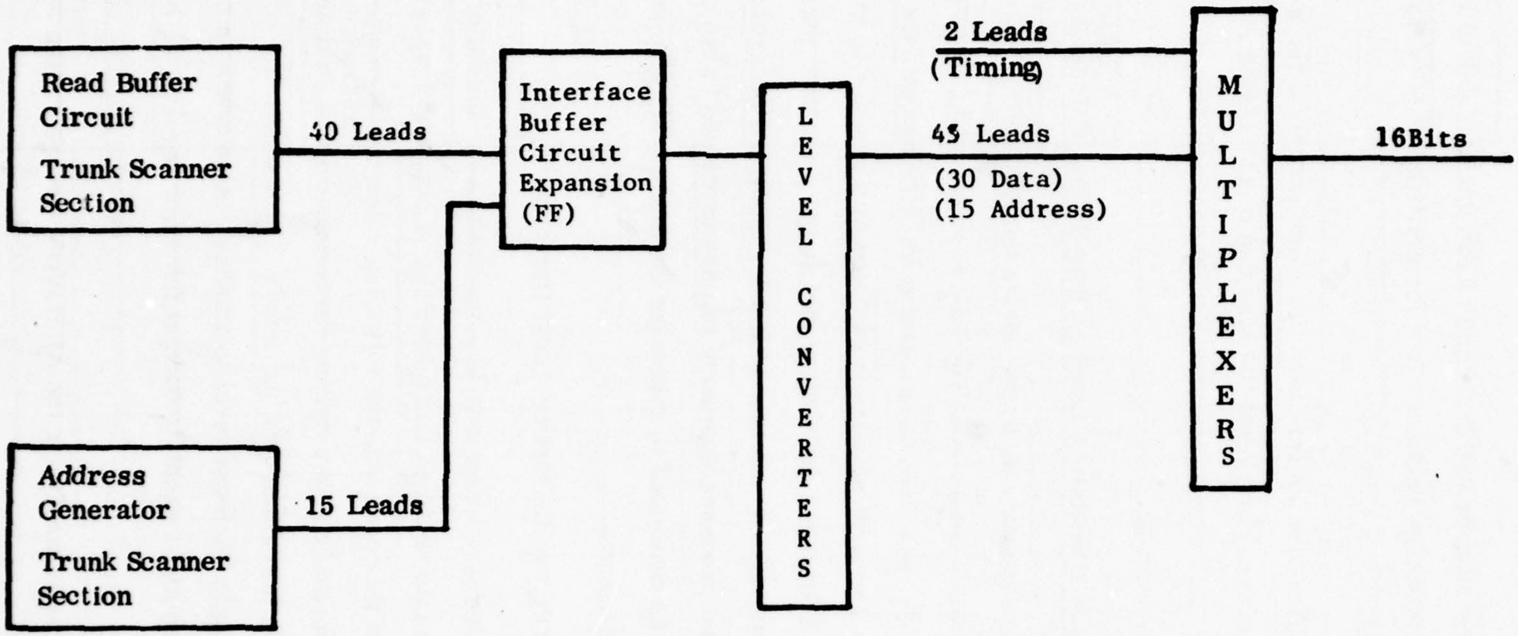


Figure 6.2-6. Trunk Scanner Interface Functional Diagram

Magnetic tape storage will be required for journaling data from the call in progress and call blockage registers in a format from which data summaries can easily be extracted.

An intermediate disc journal for high speed access to the previous one hour's trunk usage may be necessary, and the size can be calculated at: 5 calls/second X 2 registers/call X 12 words/register X 3600 seconds/hour = 432,000 16-bit words for one hour storage.

6.2.5 AUTOVON Switch Station Level Module Software Considerations

During the preliminary software design the AUTOVON switch station level module, the functions to be performed were analyzed and software routines identified. A program hierarchy was derived by placing the routines into the appropriate level of the hierarchy. The first paragraph explains this process in greater detail. The second paragraph addresses the routine sizing and processor memory requirements. The routines are estimated in terms of lines of code and program and data occupancy requirements. The processor memory requirements are based on an overlay structure which was developed to minimize the amount of core memory required for the applications programs.

6.2.5.1 AUTOVON Module Station Level Hierarchy

During the design certain software functions were identified. These functions were broken down into routines and placed into a program hierarchy containing six levels. As part of this process, the following rules pertaining to hierarchical structures were observed. In a calling sequence, a given routine may only call routines located on lower hierarchical levels. This ensures a controlled downward flow of software logic from one level to another. Also routines possessing similar capabilities and functions should reside at the same level in the hierarchy.

The software hierarchy for the AUTOVON module station level is shown in Figure 6.2-7.

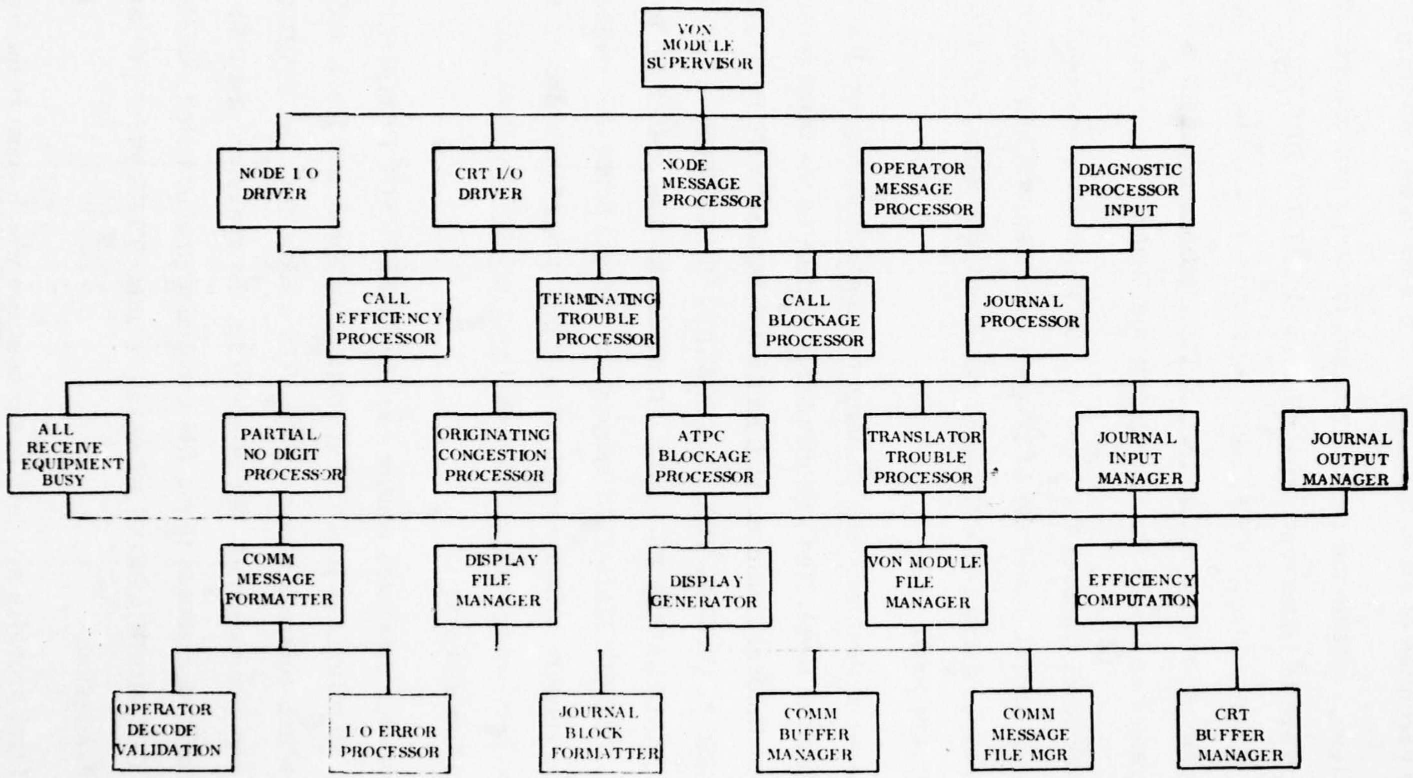


Figure 6.2-7. AUTOVON Station Level Module Software Hierarchy

The highest level of the hierarchy contains the VON MODULE SUPERVISOR which controls the execution of all of the scheduled events in the software system.

The second level contains the I/O drivers and message processors. Included as a part of this group are the interrupt-driven Node and CRT I/O DRIVERS and the Operator and Node MESSAGE PROCESSORS. Also, a processor to handle the input from the Diagnostic Processor is included in this level. The message processors supervise the message decoding and then invoke the appropriate function overlay structure.

The next lower level contains the four routines which are responsible for performing the major operations of the AUTOVON Switch Station level module. These operations include supervising call efficiency, terminating trouble, call blockage and journal processing functions.

The fourth level of the hierarchy contains routines which support the operational routines on the previous level. The call efficiency routine on the third level is supported by the following fourth level routines: ALL RECEIVE EQUIPMENT BUSY, PARTIAL/ NO DIGIT PROCESSOR, ORIGINATING CONGESTION PROCESSOR, ATPC BLOCKAGE PROCESSOR and TRANSLATOR TROUBLE PROCESSOR. The JOURNAL INPUT MANAGER and the JOURNAL OUTPUT MANAGER support the journal processor on the previous level. Thus the functional support software minimizes duplication of software by providing a level of separation between the major functional routines and the lower level support provided by levels five and six.

The fifth level contains such routines as the EFFICIENCY COMPUTATION which supports the five call efficiency processing routines on the fourth level, the VON MODULE FILE MANAGER which controls access to the VON module file, the DISPLAY GENERATOR which supervises the generation of CRT displays for the operator, the DISPLAY FILE MANAGER which provides access to the file containing preformatted skeleton CRT displays, and the COMMUNICATIONS MESSAGE FORMATTER which prepares system messages for transmission.

The lowest level provides six very basic routines which support the system activities. These routines include message type decoding, error processing, I/O buffer management and journal blocking.

6.2.5.2 **Software Sizing**

This paragraph addresses the software sizing of the AUTOVON Switch Station Level Module. As a part of the design process, the software routines were identified and estimated as to the number of lines of code and also the program and data occupancy requirements were addressed. An overlay structure was then developed to decrease the processor memory requirements.

The program sizing is based on an estimation of the number of lines of HOL code required to implement each routine identified in the AUTOVON Switch Station Level Module hierarchy (Paragraph 6.2.5.1) and additional memory requirements to accommodate data for each of these routines. The sizing includes applications software and operating system modifications/enhancements only and assumes that the host computer supplies the necessary support software.

The support software required includes a basic operating system with an overlay linker/loader, a task manager to control the swapping of programs from secondary storage and a capable file manager supporting the programs and data storage on disk. For program development, an HOL compiler (i.e. FORTRAN, COBOL, PL/I) is needed along with a text editor and an assembler.

The VON Module program sizing at the switch level is shown in Table 6.2-1. The program occupancy for each routine is based on an expansion ratio of 15 bytes of storage for each line of HOL. This ratio is typical of 16-bit word length machines using currently available HOL compilers. Section 1.4 provides further justification for this expansion ratio. For the I/O driver routines and the call efficiency processing routine the data occupancy includes buffer and table space needed by those routines. The total memory requirement for the VON Module Station Level application software is 44K bytes without the use of overlays.

Since the software system described above is functionally partitionable, it is applicable to incorporate it into an overlay structure. The use of overlays, where on-line secondary storage capabilities are available, minimizes processor memory requirements by retaining the low demand software on disk.

Table 6.2-1. AUTOVON Station Level Module Sizing Summary

PROGRAM NAME	FUNCTION	# Inst HOL	Prog. Occupancy (Bytes)	Data Occupancy (Bytes)
VON Module Supervisor	Controls all scheduled software activities	200	3000	
Node I/O Driver	Performs Node Line Handling	100	1500	100
CRT I/O Driver	Performs CRT Line Handling	100	1500	2000
Node Message Processor	Performs preliminary message processing of node input	50	750	
Operator Message Processor	Performs preliminary message processing of operator messages	50	750	
Diagnostic Processor Input	Performs preliminary message processing of diagnostic processor input	50	750	
Call Efficiency Processor	Supervises call processing efficiency calculations	100	1500	168
Terminating Trouble Processor	Supervises type of terminating trouble determination	75	1125	
Call Blockage Processor	Determines cause of precedence blockage and directional overload on interswitch trunk groups	200	3000	
Journal Processor	Controls the input and output of journal data	100	1500	
All Receive Equipment Busy	Notifies controller upon detection of all receive equipment busy condition	50	750	
Partial/No Digit Processor	Detects interswitch trunk partial or no digits received	50	750	
Originating Congestion Processor	Detects originating congestion condition	150	2250	
ATPC Blockage Processor	Notifies ACOC and node of ATPC blockage condition	50	750	
Translator Trouble Processor	Determines level of precedence blockage	75	1125	
Journal Input Manager	Processes all data into the journal	175	2625	
Journal Output Manager	Processes all data from the journal	50	750	
Communications Message Formatter	Formats messages for data link transmission	150	2250	
Display File Manager	Performs retrieval of standard system displays	50	750	
Display Generator	Parametrically builds system screen displays	50	750	
VON Module File Manager	Provides access to the VON Module file	100	1500	
Efficiency Computation	Computes the call processing percent efficiency	200	3000	
Operator Decode/Validation	Performs message type determination and validation	75	1125	
I/O Error Processor	Performs recovery processing upon communication error detection	150	2250	
Journal Block Formatter	Builds blocks of data for output to the journal	150	2250	
Communications Buffer Manager	Maintains the data link I/O buffers	100	1500	
Communications Message File Manager	Performs retrieval of standard system communications messages	50	750	
CRT Buffer Manager	Maintains the CRT input buffers	75	1125	

Total Lines of Code 2,775
Total Program Occupancy 41,625
Total Data Occupancy 2,268

An overlay structure for the VON module software at the switch level was developed by separating the routines contained in the program hierarchy into functions. Table 6.2-2 summarizes the overlay structure. These overlays perform set functions such as journal, call efficiency, terminating trouble, call blockage processing and operator interaction. Depending on the function to be performed, only one of these overlays would be in memory at any time.

In order to determine the amount of memory required for applications software, it is necessary to add all of the memory requirements for the routines which support a given function. Table 6.2-2 shows that the largest memory requirement occurs for processing call efficiency. In this case the applications software requires 28,068 bytes of main memory. This sizing is only for the applications programs and relies on a host computer for the support software. Thus, the total memory requirements for the AUTOVON Switch Level Module has been determined to be 28K bytes.

6.2.6 Desired Data Outputs

AUTOVON switch level module outputs should include flags and trouble indicators to the node for correlation with transmission status for detection of link or trunk problems which may be preventing call completion by the AUTOVON switch.

Outputs to the ACOC Level AUTOVON Module should include switch trouble indicators, trunk trouble indicators and traffic overload conditions for use by the ACOC program in recommending remedial actions by the ACOC controller for alleviating overload conditions on the network.

The proposed outputs from the AUTOVON switch level module follow:

a. Percent of call processing efficiency by Register Junctor*.

b. Percent of call processing efficiency by Switch *.

*To appropriate processing module on unsatisfactory threshold detection

Table 6.2-2. AUTOVON Switch Level Module Processor Function Sizing Summary

PROGRAM NAME	# Inst HOL	Occupancy (Bytes)	Journal Processing	Call Efficiency Processing	Terminating Trouble Indication	Call Blockage Indication	Operator Interaction						
VON Module Supervisor	200	3000	X	X	X	X	X						
Node I/O Driver	100	1600	X	X	X	X	X						
CRT I/O Driver	100	3500	X	X	X	X	X						
Node Message Processor	50	750		X									
Operator Message Processor	50	750					X						
Diagnostic Processor Input	50	750		X	X								
Call Efficiency Processor	100	1668		X									
Terminating Trouble Processor	75	1125			X								
Call Blockage Processor	200	3000				X							
Journal Processor	100	1500	X										
All Receive Equipment Busy	50	750		X									
Partial/No Digit Processor	50	750		X									
Originating Congestion Processor	150	2250		X									
ATPC Blockage Processor	50	750		X									
Translator Trouble Processor	75	1125		X									
Journal Input Manager	175	2625	X										
Journal Output Manager	50	750	X										
Communications Message Formatter	150	2250		X	X	X							
Display File Manager	50	750		X			X						
Display Generator	50	750		X			X						
VON Module File Manager	100	1500		X	X	X	X						
Efficiency Computation	200	3000		X									
Operator Decode/Validation	75	1125					X						
I/O Error Processor	150	2250		X									
Journal Block Formatter	150	2250	X										
Communications Buffer Manager	100	1500		X	X	X							
Communications Message File Manager	50	750		X	X	X							
CRT Buffer Manager	75	1125		X			X						
Total Occupancy			15225	28068	15975	17100	14100						

c. Flags and Trouble indicators for:

1. Originating Trunk Trouble

(a) Interswitch trunk and partial or no digits received**

(b) Class mark lookup and translator trouble

(c) Precedence blocked by translator trouble flagged by precedence level and originating trunk

(d) Pool equipment overload during origination

(e) Special Interest Indicator

2. Terminating Trunk Trouble

(a) No start after trunk selection**

(b) Time out during dialing out by switch**

(c) Call durations of less than a threshold time on dial pulse terminating trunks**

(d) Special Interest Indicator

3. Pool Equipment Overloads

(a) MF 2/6 Transceiver overload when call processing efficiency is below threshold*

(b) TCMF receiver overload when processing efficiency is below threshold*

(c) Line Load control by class, ATOP and ARB commands

(d) Pool equipment assignment trouble when call processing efficiency is below threshold*

6.2.6.1 Output Development

The following is an explanation of the development of the above listed outputs.

a. Call processing efficiency can be determined by comparing the number of successfully terminated calls with the number of originated calls.

An origination is assumed when the register junctor exits from Processor Control Sequence State DCX 1 to DCX 2.

* To appropriate processing module on unsatisfactory threshold detection
** To node for correlation

A termination is assumed when the register junctor exits from DCX 35 to DCX 36.

A call is assumed to be completed successfully regardless of the terminating trunk unless one of the following conditions causes the call to be terminated to an announcement or tone trunk:

(1) Translation Instruction 20 (Operating Equipment Irregularities)

(2) Translation Instruction 25 (No Dialed Digits) and an Originating Interswitch Trunk

(3) Translation Instruction 26 (Partial Digits) and an Originating Interswitch Trunk

(4) Calls terminated to the 29xx Trunk Group (Switch Isolated by ATPC Plan)

Calls attempted, but blocked by a failure to clear both switch markers prior to the processor exit to DCX2 will be considered call attempts, but because there will be no final disposition of the call in common control, it will be considered an *incomplete connection*. Many of the outputs depend upon reaching appropriate thresholds. The threshold values included are approximations, and can easily be changed to accommodate more realistic thresholds if experience dictates the initial threshold to be unrealistic.

By products of the computations and comparisons required for calculating call processing efficiency will be the ability to determine many of the other listed overload and trouble conditions. A few additional processing steps are required, but each will result in an output flag and indicator to the Node or ACOC processing module, and in some instances to the diagnostic processor for further correlation and display where necessary to the appropriate level of control.

Since the ability to make control decisions rests with the ACOC Network Controller, data reduction and suggested control actions involving more than one switch will be accomplished at that level. In the few instances where a control action can be suggested on the basis of data collected from one switch, a flag to that effect will be transmitted to the ACOC along with the trouble or overload message.

The percentage of call processing efficiency is the key to reporting most overload and troubles from each switch, i.e., if the switch is satisfactorily terminating all calls except low precedence (Priority or Routine) there is no reason to impose controls to alleviate the congestion.

A separate routine will address blockage of immediate or higher precedence calls, and will give the network controller visibility of these conditions.

6.2.6.2 Flowcharts

The flowcharts developing the AUTOVON switch level module functions are described in the following paragraphs. Abbreviations used in these flowcharts are explained in Table 6.2-3.

6.2.6.2.1 Call Processing Efficiency

This algorithm develops the following outputs:

- Switch Call Processing Efficiency Percentage
  (If Requested)
  (If Degraded)
- Individual Register Junctor Call Processing Efficiency Percentage
  (If Requested)
  (If Degraded)
- MF Transceiver Equipment Overload
- TCMF Receiver Equipment Overload
- Assigner Problem (To Diagnostic Processor)
- Assigner Problem (To ACOC If Call Processing is Degraded)
- Originating Interswitch or Special Interest Circuit Problem (To Node)
- Access of ATPC Plan #2 Routing
- Originating Congestion

Table 6.2-3. Flowchart Abbreviations

DCX - Decoded CX (Process Control Sequence State)

T.I. - Translation Instruction

Tk - Trunk

LO - Lock Out (Command to Switch Marker)

TT - Identifies Originator as Using DTMF (TCMF) Address Signaling

TAMFB - All MF Transceivers Busy

TATTB - All TCMF Receivers Busy

ATPC - Automatic Traffic Plan Control
    Plan # 1 - Code Cancellation (Deletes Automatic Alternate Routes)
    Plan # 2 - Code Isolation (Routes calls of affected dialed digits to Isolated Code Announcement)

Dialed Precedences
    3 - Priority
    2 - Immediate
    1 - Flash
    0 - (Binary 10) Flash Override

PMB - Pilot Make Busy

ATOP - Automatic Traffic Overload Protection locks out from call origination all trunks provided with Line Load Control strapping. This occurs when a threshold of number of busy Register Junctors is exceeded. The threshold is set by a switch at the Maintenance Console.

ARB - All Register Junctor Busy - This control prevents any incoming calls from being recognized by the Switch Markers.

LLC A, B, C - Line Load Control, A, B, or C. Strapping that allows trunks to be locked out from call origination in three sets. Set A, Set B and Set C. This control is manually imposed.

SS - Switch Marker Sequence State

- Automatic Traffic Overload Protection
- All Register Junctor Busy
- Line Load Control A, B, or C

The Call Processing algorithm is divided into the following specific subroutines:

- General
- All Receive Equipment Busy
- Partial or No Digits
- Originating Congestion
- ATPC Blockage
- Compute Percent Efficiency
- Translator Trouble

a. The General Subroutine, Figure 6.2-8, collects call attempts, call completions and call blockages by counting the processing flow through appropriate call processing sequence states and development of the translation instruction which indicates call blockages.

b. The All Receive Equipment Busy Subroutine, Figure 6.2-9, isolates the cause of blockage indicated by equipment operating difficulty indications, and sends the appropriate message to the appropriate level of control.

c. The Partial or No Digit's Subroutine, Figure 6.2-10, isolates the dialing of partial addressing digits by automatic equipment or special interest circuits to the path over which the partial digits are received, and reports originating trunk trouble to the node.

d. The Originating Congestion Algorithm, Figure 6.2-11, determines an overload of calls awaiting dialed digits an abnormally long time (10 seconds), and sends originating trunk trouble messages to the Node for all

circuits in this status at the end of that time. This subroutine also determines automatic traffic overload protection, all register junctors busy, line load control conditions, and call attempts represented by calls blocked through switch marker failure.

e. The ATPC Blockage Subroutine, Figure 6.2-12, reports accesses to ATPC Code 2 announcement to the switch and ACOC.

f. The Compute Percent Efficiency Subroutine, Figure 6.2-12, calculates the call processing efficiency of each register junctor using call attempt, call completion, and call blockage data from the General Subroutine, and sends percentage to requesters or to the appropriate level of control if the efficiency does not exceed a degradation threshold.

g. The Translator Trouble, Figure 6.2-13, interleaves with the Call Blockage Algorithm in maintaining call blockage by precedence, and notifies the diagnostic processor of translator troubles indicated by abnormal call processing sequence state changes not normally detected by the switch diagnostics.

6.2.6.2.2 Terminating Trouble Indicator

This algorithm develops the following outputs:

- Flag and Trunk Identity to Nodal Processor
- Flag indicating an Overload in a Connecting Tandem Switch

Call processing trouble reports indicating probable transmission system problems or distant switch overloads are received from the AUTOVON switch diagnostic processor. A correlation of the trouble report with register junctor data is followed by a test of the alternate routing counter.

If the alternate route counter is not at the overload point, the terminating trunk identity is sent to the nodal processor for correlation with known system problems.

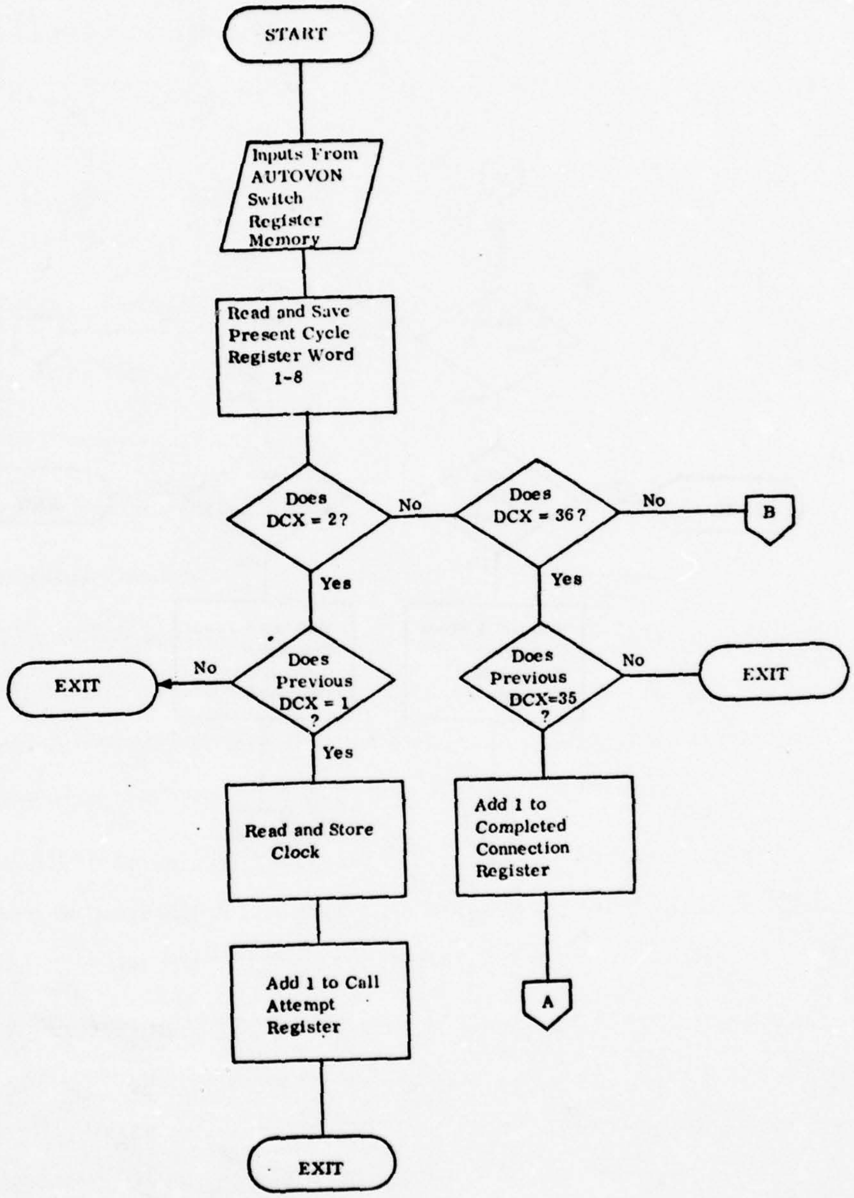


Figure 6.2-8. Call Processing Efficiency - General (Sheet 1 of 3)

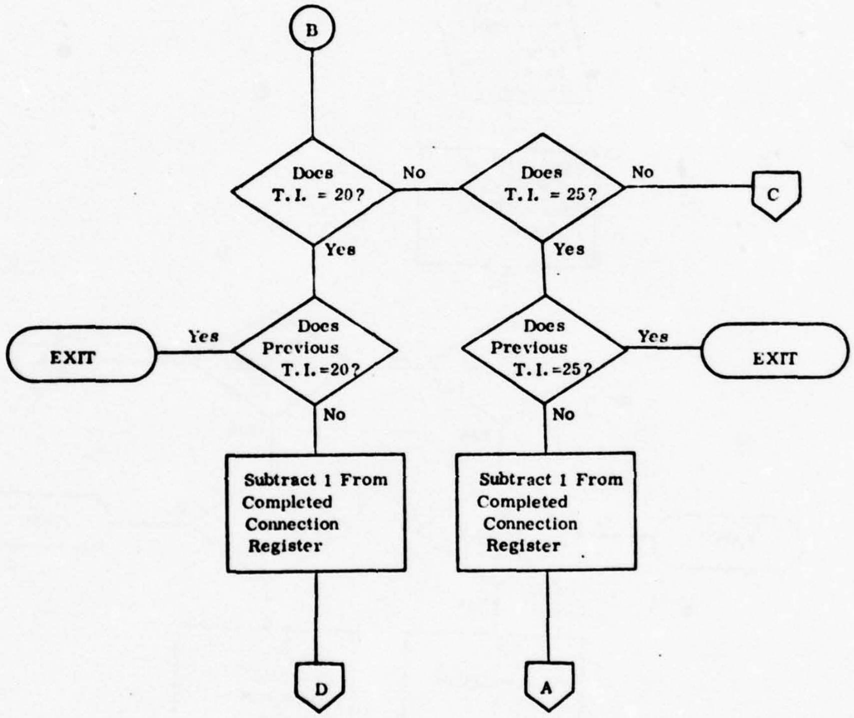


Figure 6.2-8. Call Processing Efficiency - General (Sheet 2 of 3)

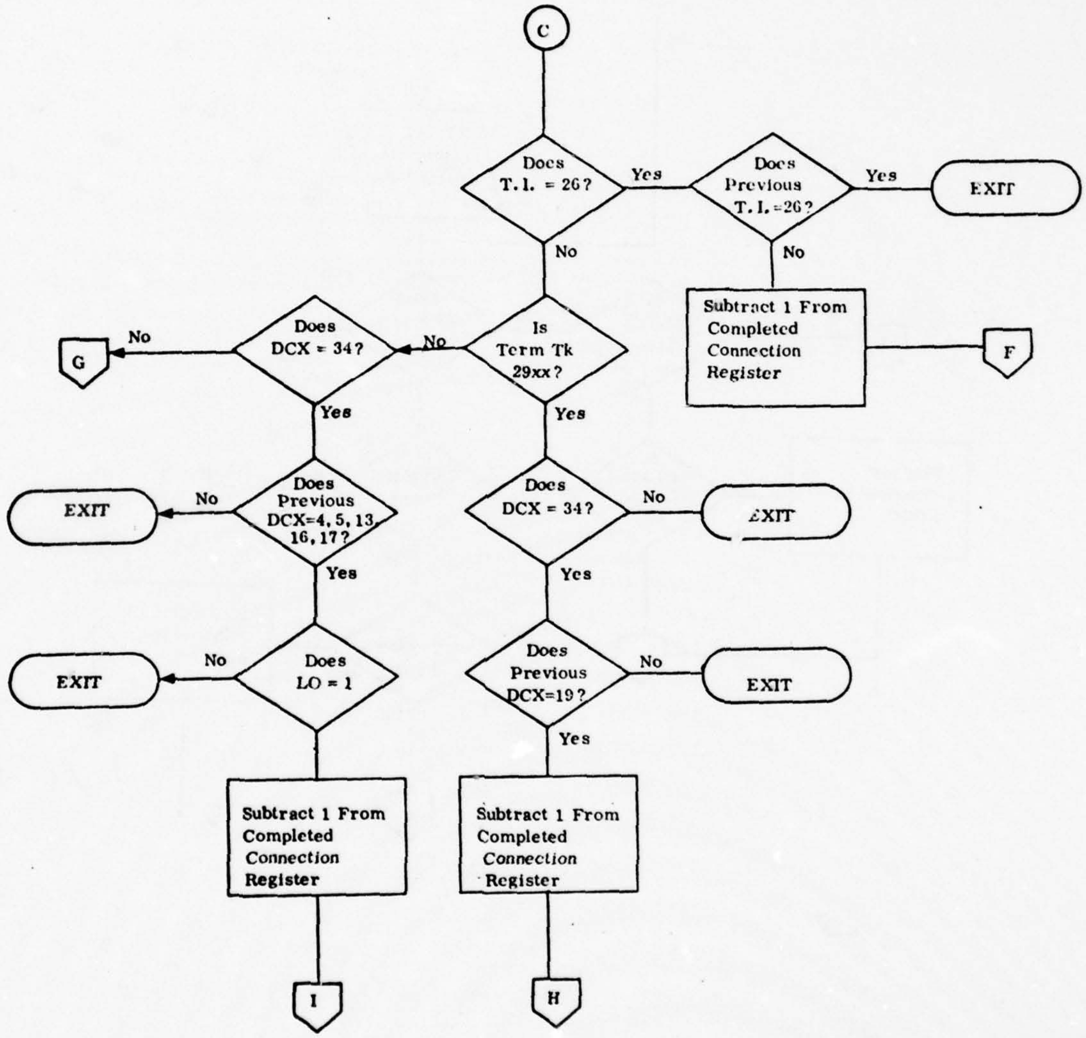
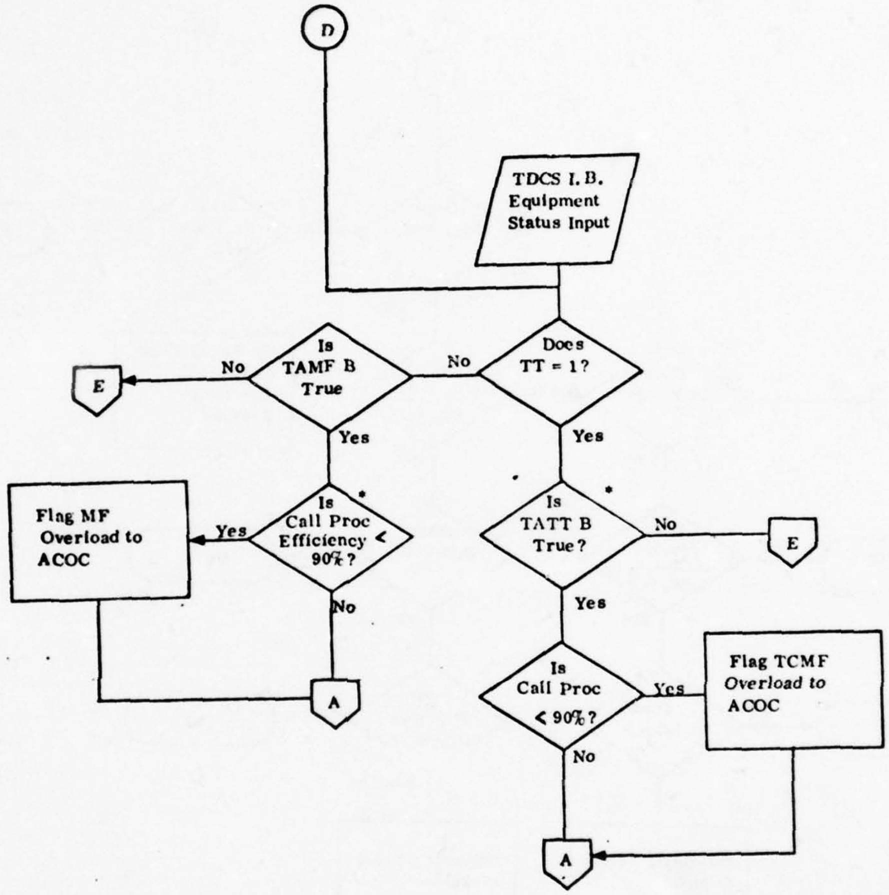
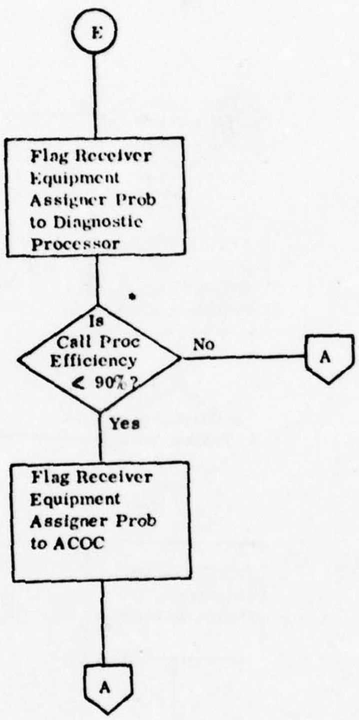


Figure 6.2-8. Call Processing Efficiency - General (Sheet 3 of 3)



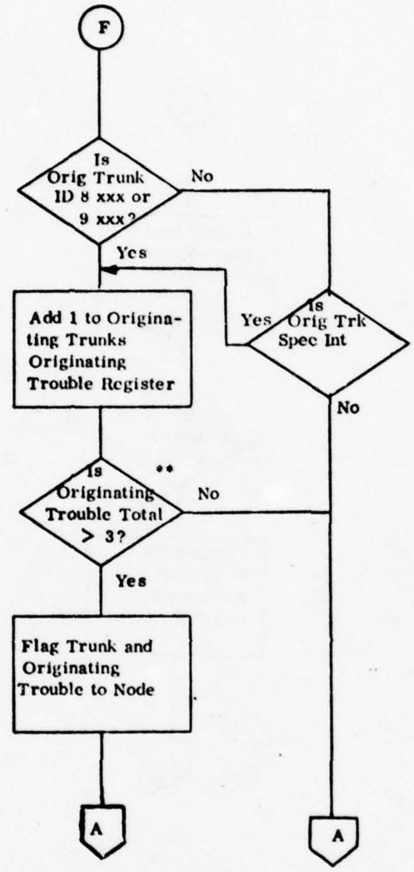
* Variable thresholds to be initially set during programming phase.

Figure 6.2-9. Call Processing Efficiency - All Receive Equipment Busy Subroutine (Sheet 1 of 2)



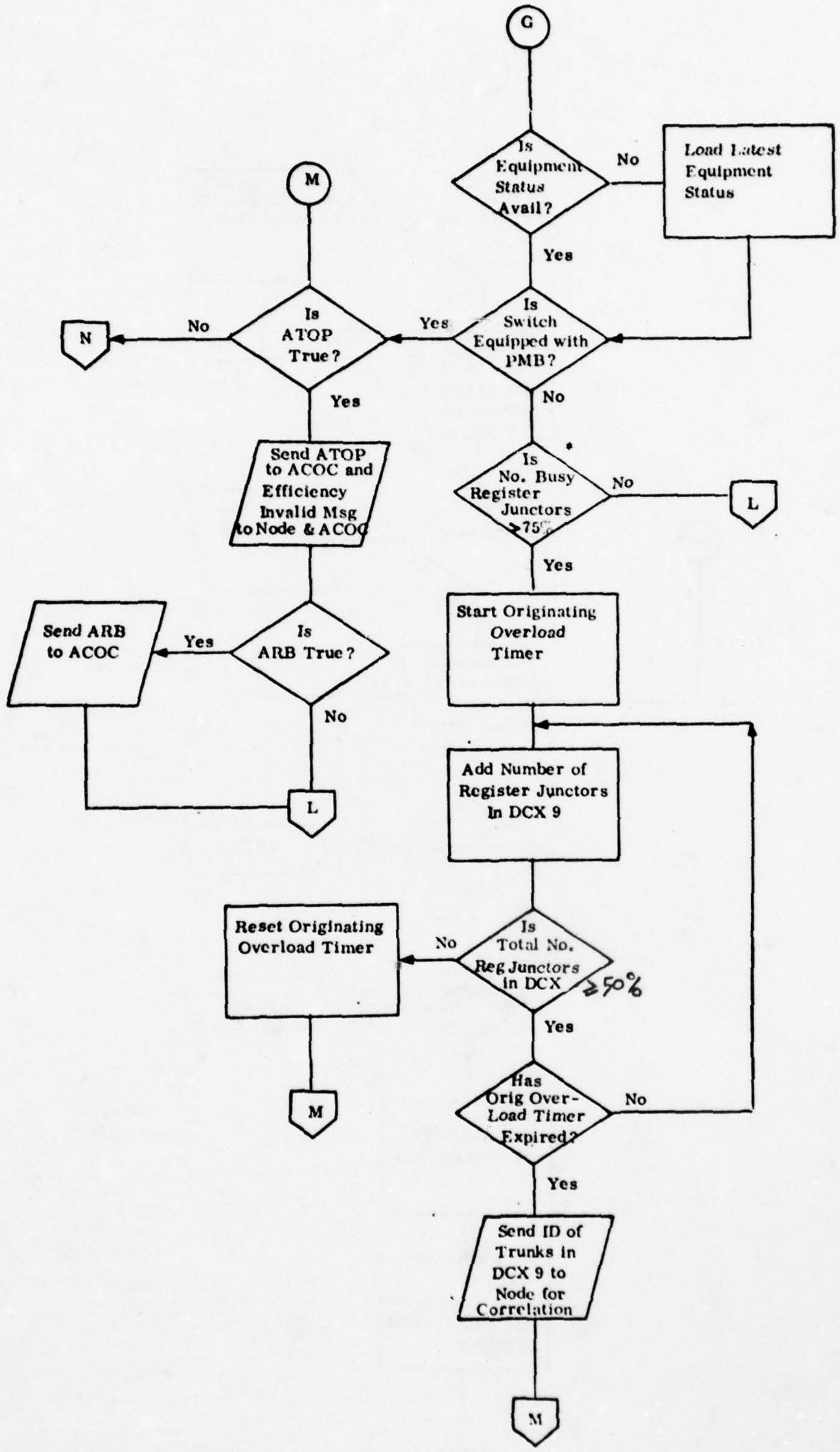
• Variable threshold to be initially set during programming phase.

Figure 6.2-9. Call Processing Efficiency - All Receive Equipment Busy Subroutine (Sheet 2 of 2)



** This value is to be a threshold of $\frac{\text{Trouble}}{\text{Time}}$ to be determined during program debugging.

Figure 6.2-10. Call Processing Efficiency - Partial or No Digits Subroutine



* Variable thresholds to be initially set during programming.

Figure 6.2-11. Call Processing Efficiency - Originating Congestion (Sheet 1 of 2)

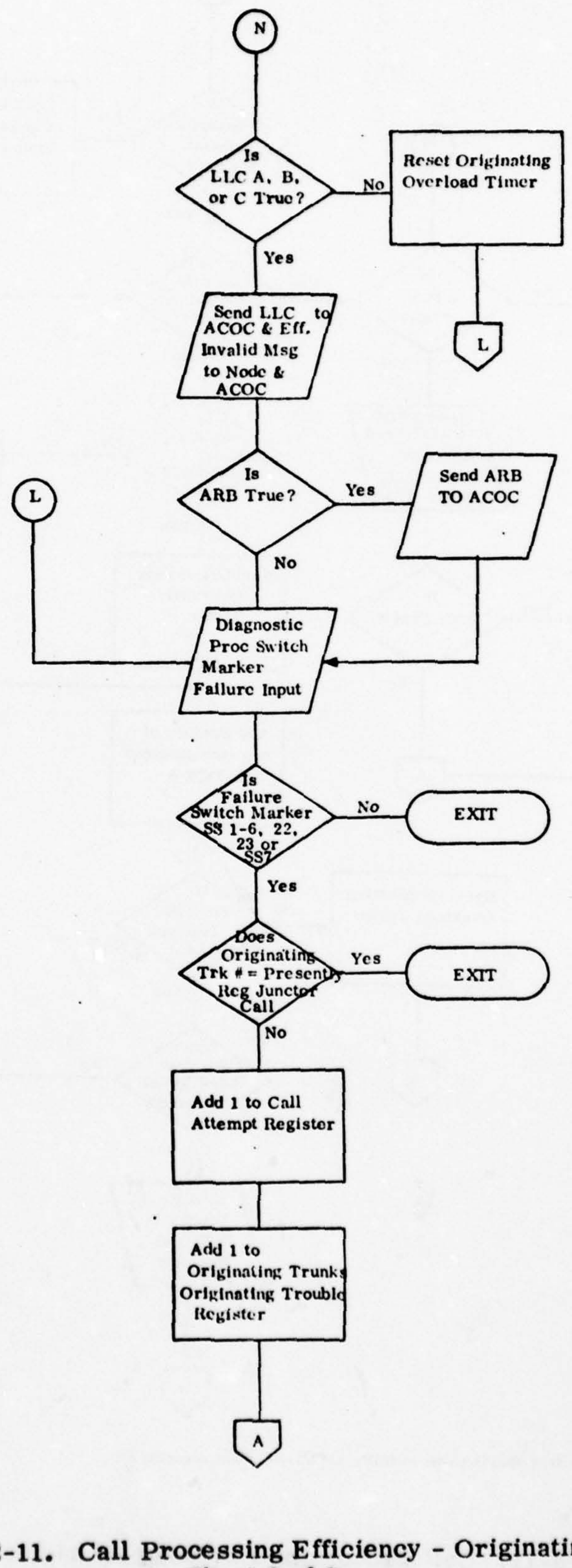
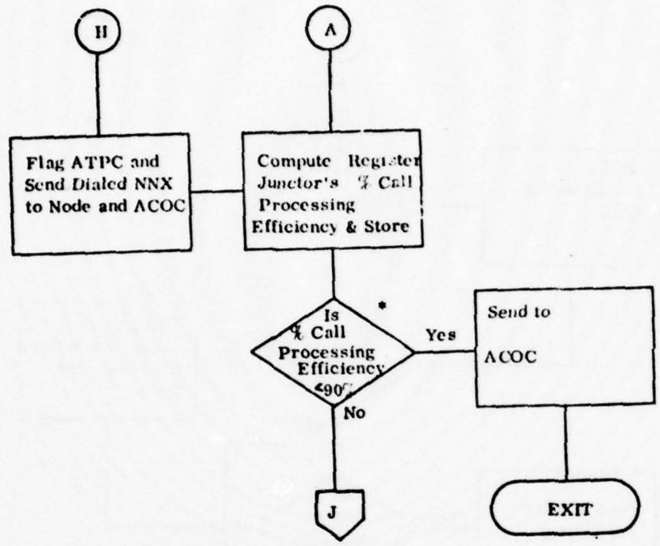


Figure 6.2-11. Call Processing Efficiency - Originating Congestion (Sheet 2 of 2)



* Variable threshold to be initially set during programming phase.

Figure 6.2-12. Call Processing Efficiency - ATPC Blockage Subroutine and Compute % Efficiency Subroutine (Sheet 1 of 2)

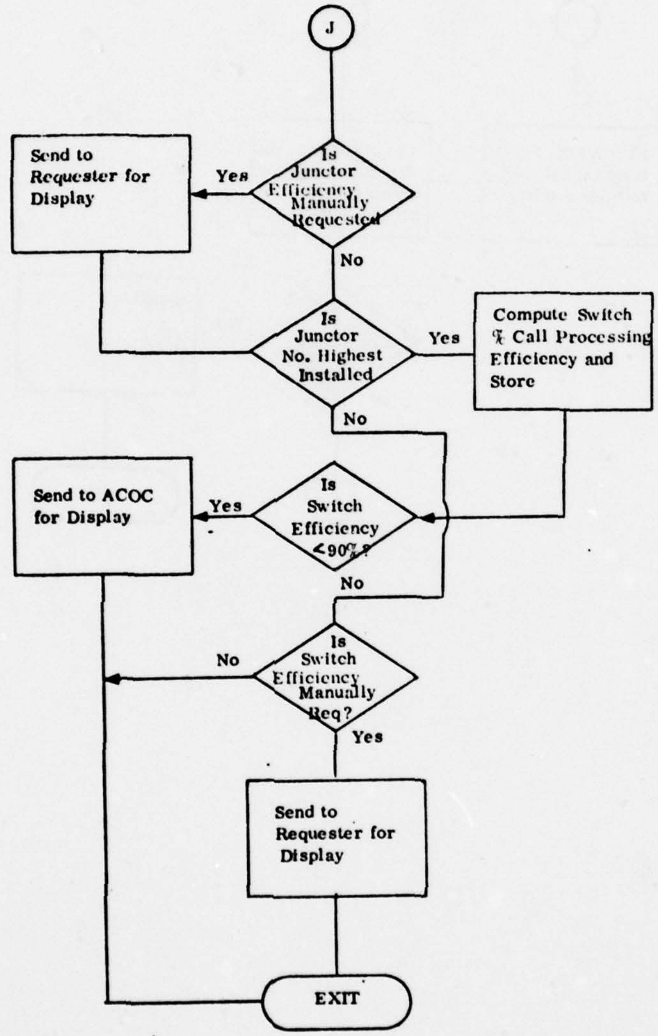


Figure 6.2-12. Call Processing Efficiency - ATPC Blockage Subroutine and Compute % Efficiency Subroutine (Sheet 2 of 2)

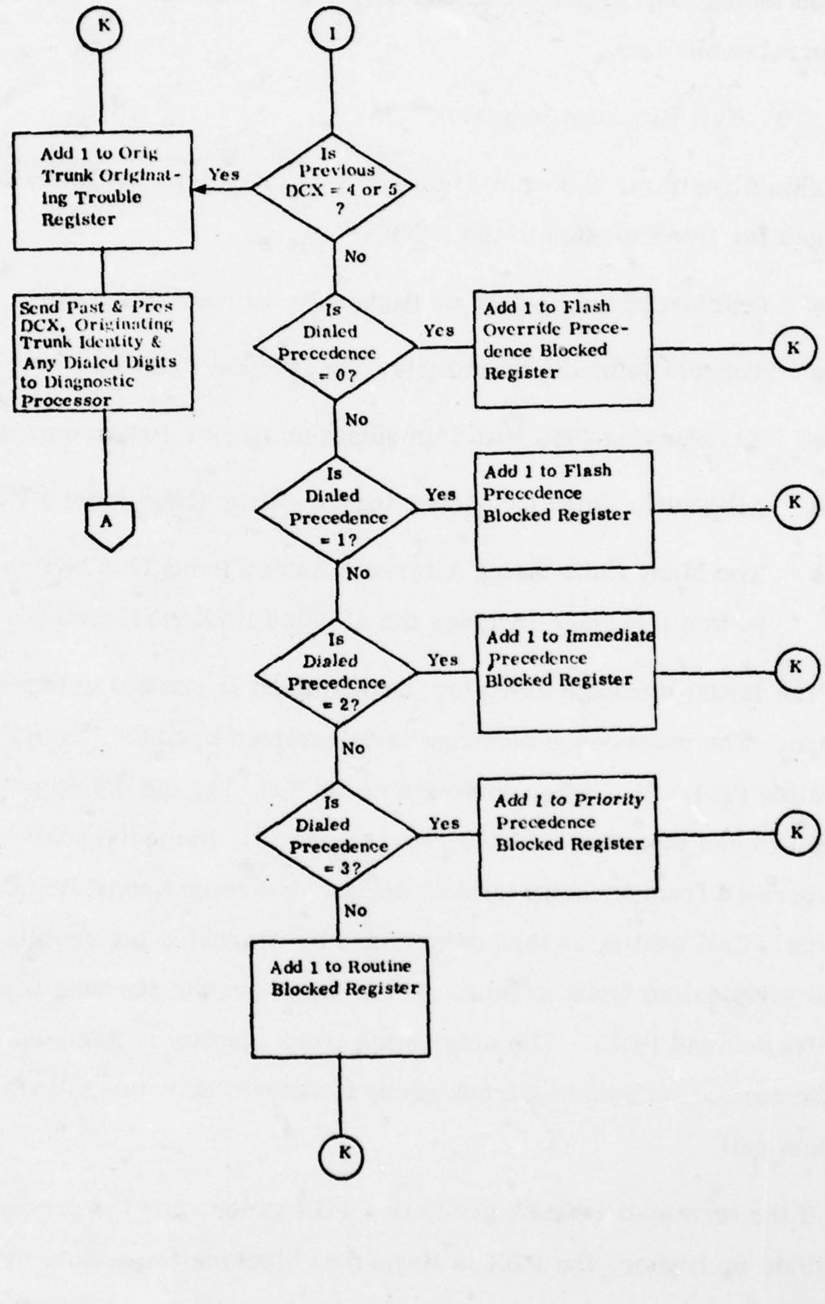


Figure 6.2-13. Call Processing Efficiency - Translater Trouble Subroutine

If the overload counter is at the overload point, a test of the call processing sequence state is made to determine if the first tandem switch is the cause of the overload indication. If so, a flag indicating this overload is sent to the ACOC along with correlatable data.

6.2.6.2.3 Call Blockage Indicator

This algorithm, shown in Figure 6.2-15, develops the following Call Blockage Messages for transmission to the ACOC:

- Originating Immediate or Higher Precedence Blockage
- Tandem Immediate or Higher Precedence Blockage
- Terminating PBX with Immediate or Higher Precedence Blockage
- All Trunks Busy and Receiving Too Many Calls from a Connecting Switch
- Too Many Calls Being Alternate Routed from This Switch to A Connecting Switch (Message includes the affected NNX/NYX codes)

The initial blockage indicator development is limited to precedence call blockage. The precedence blockage is determined by detection of a Translation Instruction (T.I.) 21. After detection of the T.I. 21, the dialed precedences are determined and stored in call blockage registers. Immediate and higher precedences are separated from Priority precedence for determination of Immediate or higher blockage. Call routing is then determined by searching the routing tables for the normal terminating trunk groups. These trunk groups are then separated by type (inter-switch and PBX). The originating trunk identity is sampled and correlated with the normal terminating trunk group to determine if the call was to have been a tandem call.

If the terminating trunk group is a PBX group, and the precedence is Immediate or Higher, the PBX is flagged as blocking Immediate or higher precedence calls. If the originating trunk group and terminating trunk group are both inter-switch trunk groups, and precedences blocked are Immediate or higher, the

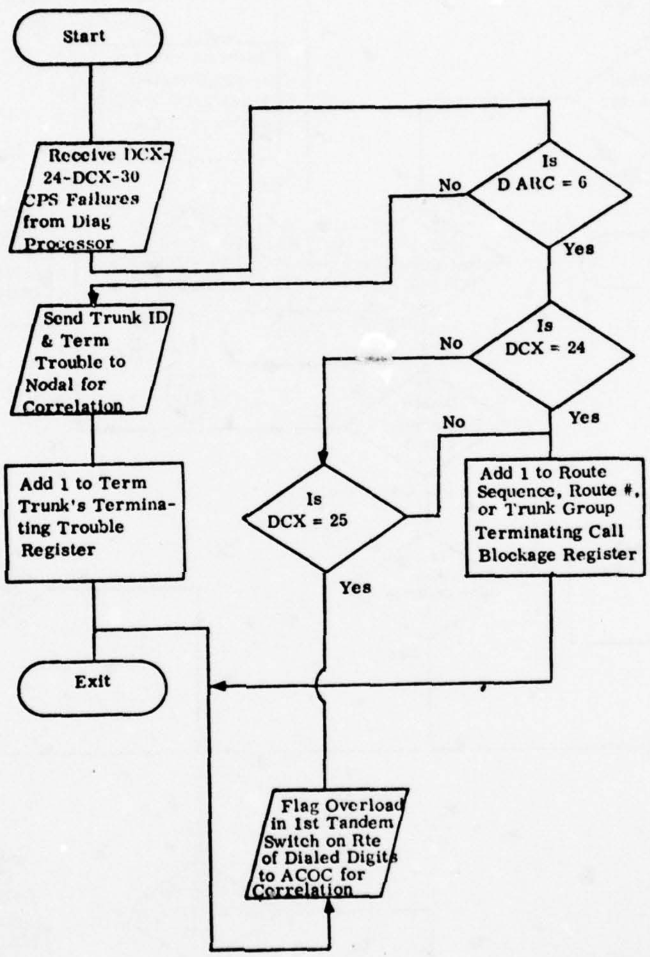


Figure 6.2-14. Terminating Trouble Indicator

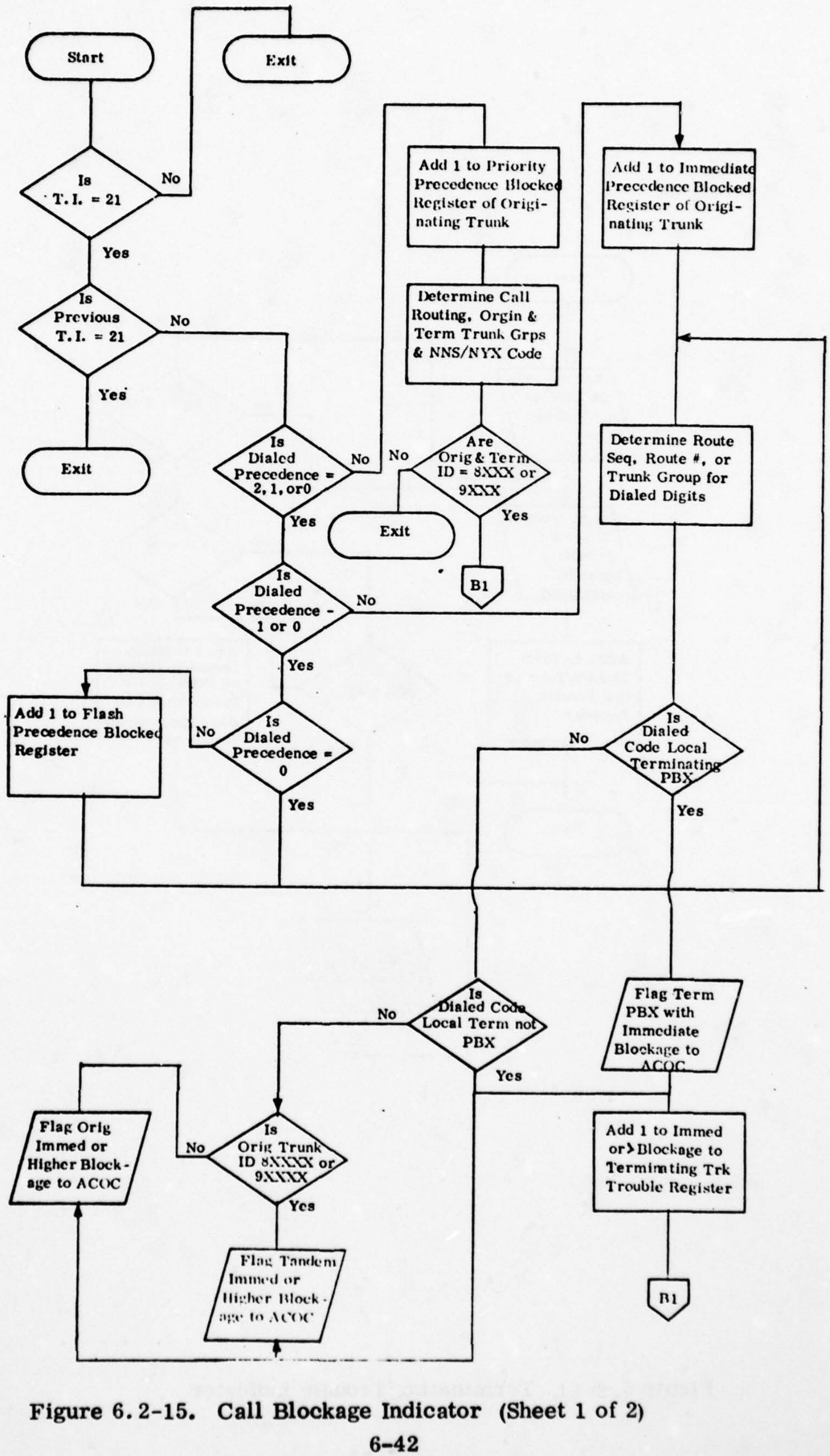


Figure 6.2-15. Call Blockage Indicator (Sheet 1 of 2)

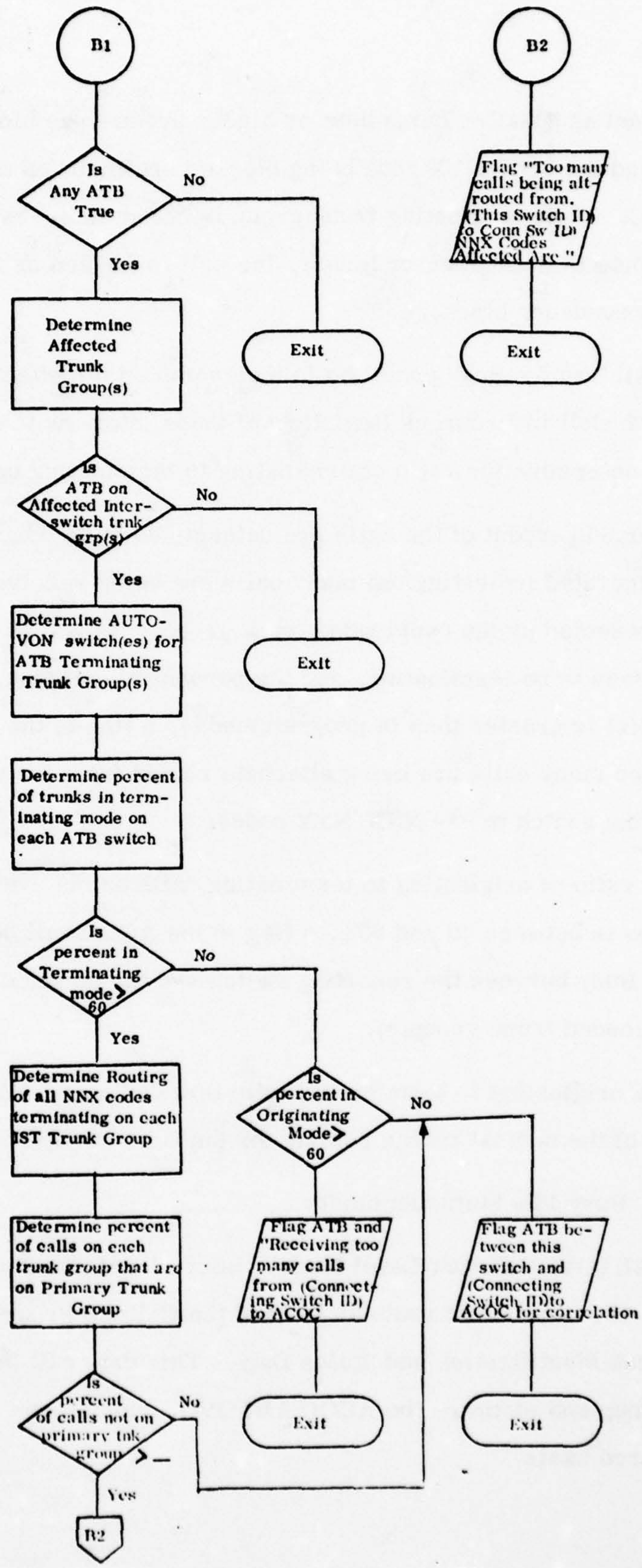


Figure 6.2-15. Call Blockage Indicator (Sheet 2 of 2)

call is flagged as Tandem Immediate or higher precedence blockage. The connecting switches, and the NNX/NYX code being blocked are included in the blockage message to the ACOC. If the originating trunk group is not an inter-switch trunk group, and the precedence is Immediate or higher, the call is flagged as Originating Immediate or higher precedence blockage.

The All Trunks Busy condition is then sampled for affected inter-switch trunk groups. The Call in Progress Registers of these inter-switch trunk groups are then sampled to determine the ratio of originating to terminating calls now standing.

If over 60 percent of the calls are determined to be originating, a flag to the ACOC is generated indicating too many calls are being received from the connecting switch represented by the overloaded trunk group. If over 60 percent of the calls are determined to be terminating, and the percent of calls not on their primary trunk group(s) is greater than (a programmed%), a flag to the ACOC is generated indicating too many calls are being alternate routed from the reporting switch via the connecting switch to --- NNX/NYX codes.

If the ratio of originating to terminating calls on the overloaded inter-switch trunk groups is between 40 and 60%, a flag to the ACOC will be generated indicating All Trunks Busy between the reporting switch and the connecting switch represented by the overloaded trunk group(s).

NOTE: The originating to terminating ratio thresholds will have to be assigned after study of the normal traffic routing for the time of day and day of week.

6.2.6.2.4 Busy Idle Status Summary

The AUTOVON Switch Level Module Busy Idle Status Summary Algorithm, Figure 6.2-16, consists of routines to read the Call-In-Progress register and extract Trunk Identification and Status Data. This data will then be summarized by trunk group and status. The ACOC AUTOVON module can request this data on an as required basis.

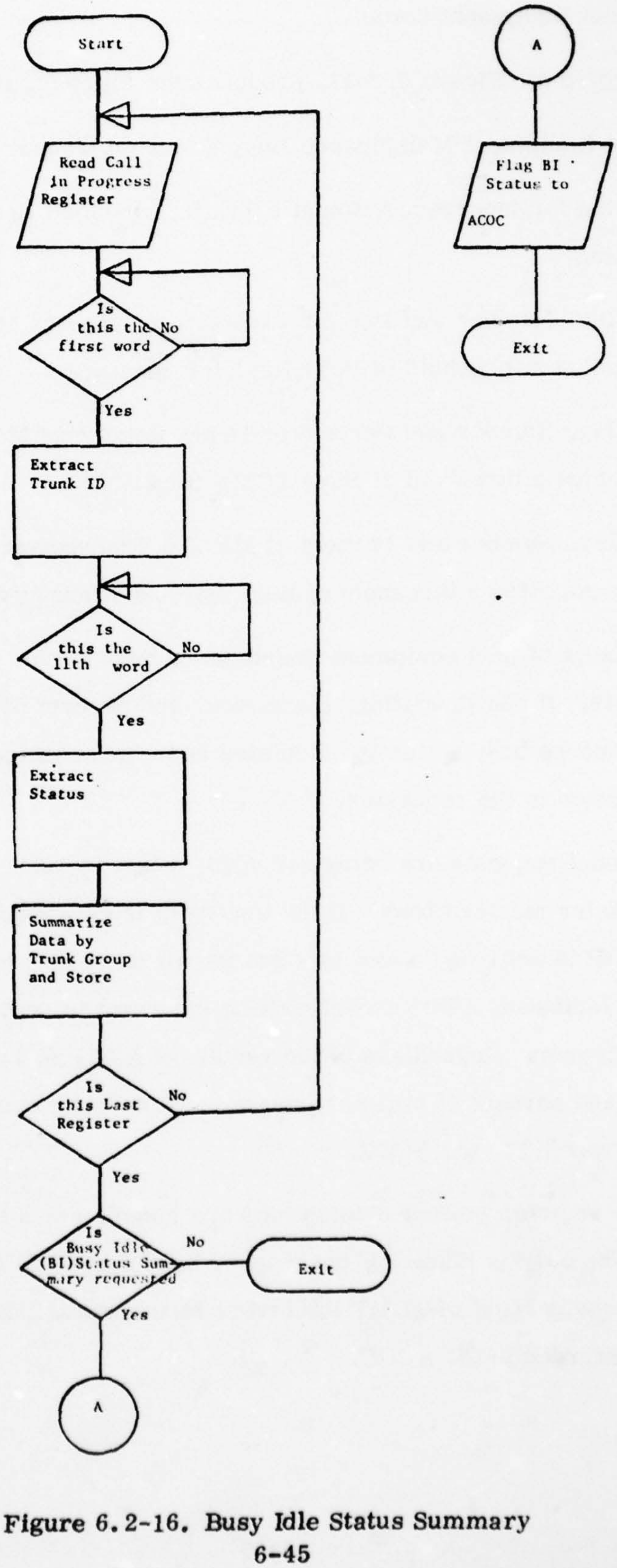


Figure 6.2-16. Busy Idle Status Summary

AD-A071 564 COMPUTER SCIENCES CORP FALLS CHURCH VA F/G 17/2
UNIFIED NETWORK/TRAFFIC TRANSMISSION MEDIA CONTROL.(U)
AUG 77 DCA100-76-C-0082
UNCLASSIFIED SBIE -AD-E100 234 NL

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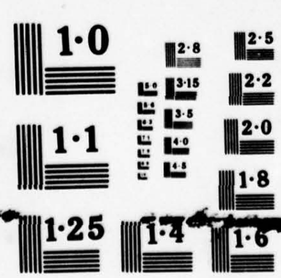

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6.2.6.2.5 Pool Equipment Status

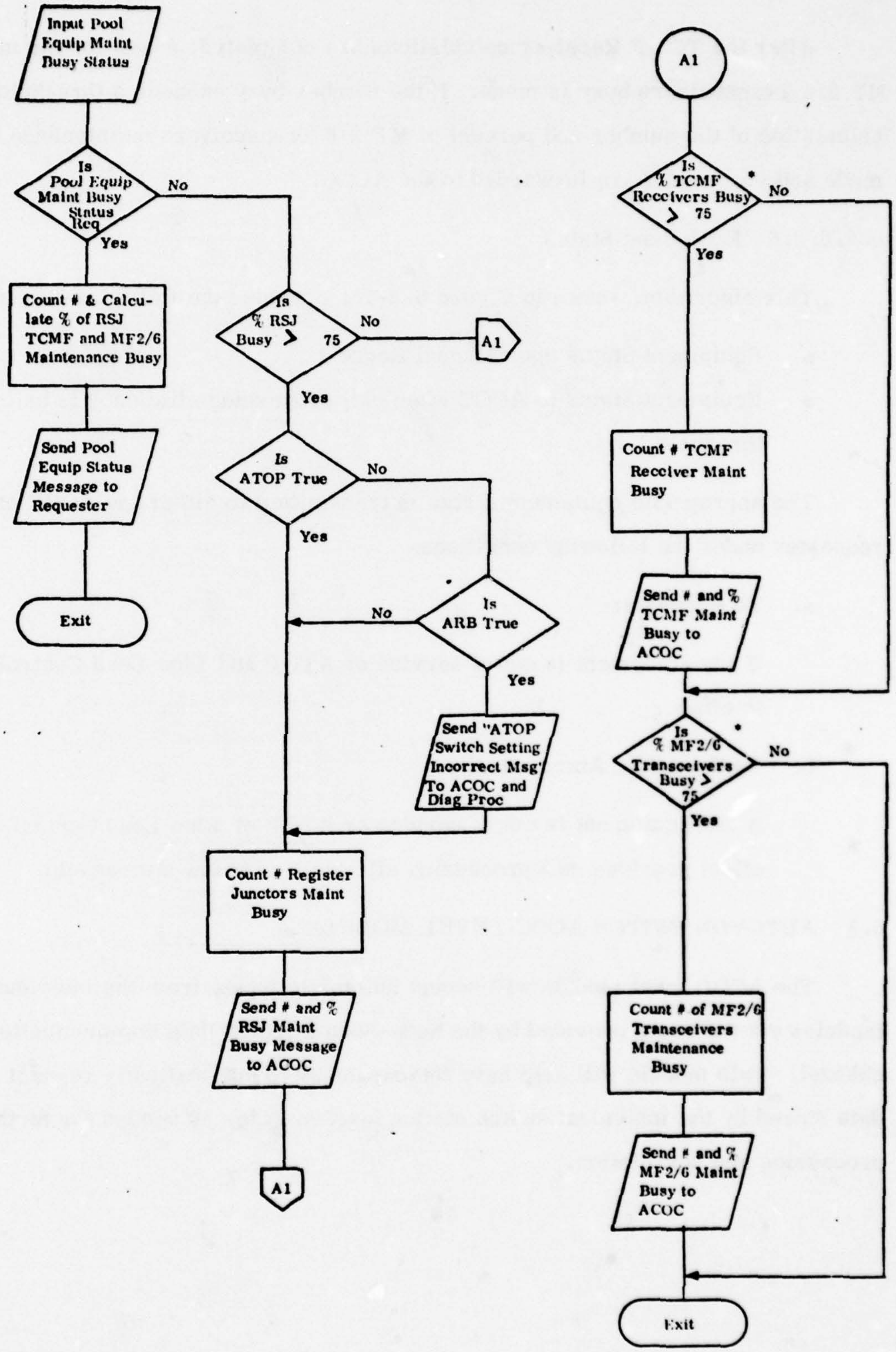
This algorithm, Figure 6.2-17, produces the following flags and information:

- Pool Equipment Maintenance Busy Status on Manual Request
- A Flag for Incorrect Automatic Traffic Overload Protection (ATOP) Switch Setting
- A Flag, Number and Percent of Register Junctors Maintenance Busy upon reaching a threshold of Busy Register Junctors
- A Flag, Number and Percent of TCMF Receivers Maintenance Busy upon reaching a threshold of Busy TCMF Receivers
- A Flag, Number and Percent of MF 2/6 Transceivers Maintenance Busy upon reaching a threshold of Busy MF 2/6 Transceivers

Upon receipt of pool equipment maintenance busy status, a test is made for manual requests. If one is waiting, the number and percent of each type pool equipment in maintenance busy status is calculated and a message containing the requested data is transmitted to the requester.

If no manual requests are being serviced, a test is made for a threshold number of register junctors busy. If the threshold is exceeded, a test is made for ATOP. If ATOP is not true, a test is made for all Registers Busy (ARB). If ARB is true, a flag indicating ATOP switch setting incorrect is sent to the ACOC and diagnostic processor. Regardless of the results of ATOP and ARB, a calculation of the number and percent of register junctors maintenance busy is made and the results are forwarded to the ACOC.

After the register junctor calculations are completed, a test for the number of TCMF Receivers busy is made. If the number busy exceeds a threshold, a calculation of the number and percent of TCMF Receivers maintenance busy is made and the results are forwarded to the ACOC.



*This figure may be changed as experience dictates

Figure 6.2-17. Pool Equipment Status

After the TCMF Receiver calculations are completed, a test for the number of MF 2/6 Transceivers busy is made. If the number busy exceeds a threshold, a calculation of the number and percent of MF 2/6 Transceivers maintenance busy is made and the results are forwarded to the ACOC.

6.2.6.2.6 Equipment Status

This algorithm, shown in Figure 6.2-18, provides the following outputs:

- Equipment Status upon Manual Request
- Equipment Status to ACOC when call processing efficiency is below a threshold

The appropriate equipment status is transmitted to either the ACOC or requester under the following conditions:

a. To Requester:

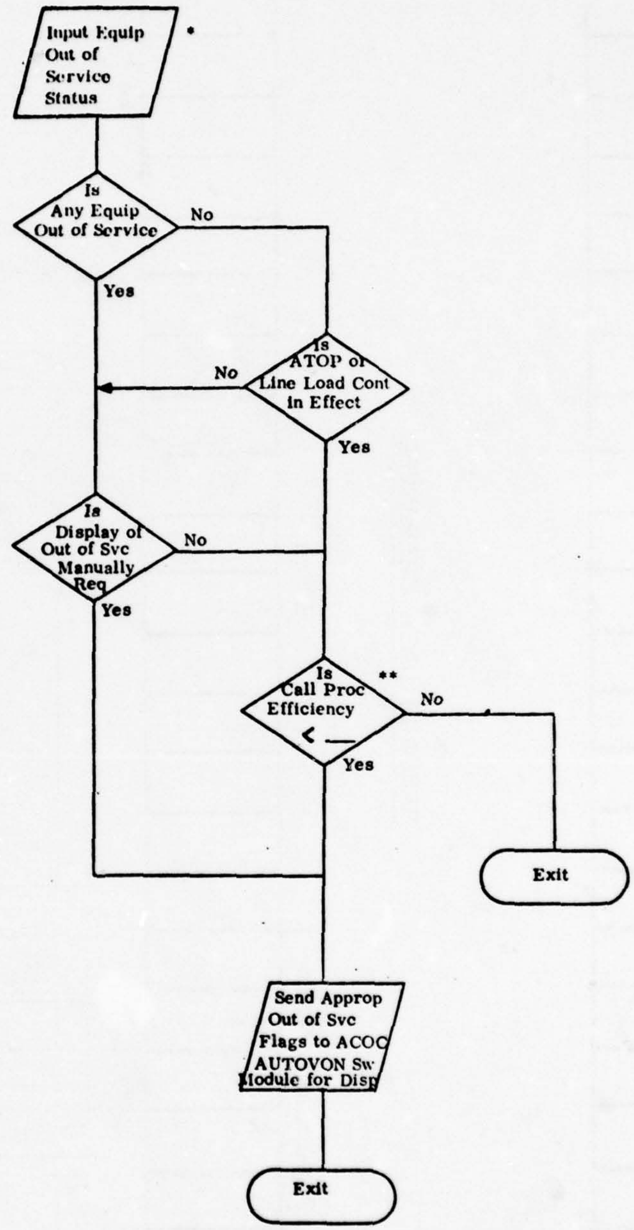
   If any equipment is out of service or ATOP and Line Load Control are not in effect

b. To the ACOC Automatically:

   If any equipment is out of service or ATOP or Line Load Control is in effect provided call processing efficiency is below a threshold

6.3 AUTOVON SWITCH ACOC LEVEL MODULE

The ACOC level module will accept automatic inputs from the individual switch modules via the route provided by the Node-Sector-ACOC data communications channel. This module will also have the capability to automatically request other data stored by the individual switch station level modules as needed for further processing and correlation.



* Logic, Memory, Switch Markers and DSA Markers Out of Service Status

** Resettable threshold to be initially determined during programming

Figure 6.2-18. Equipment Status

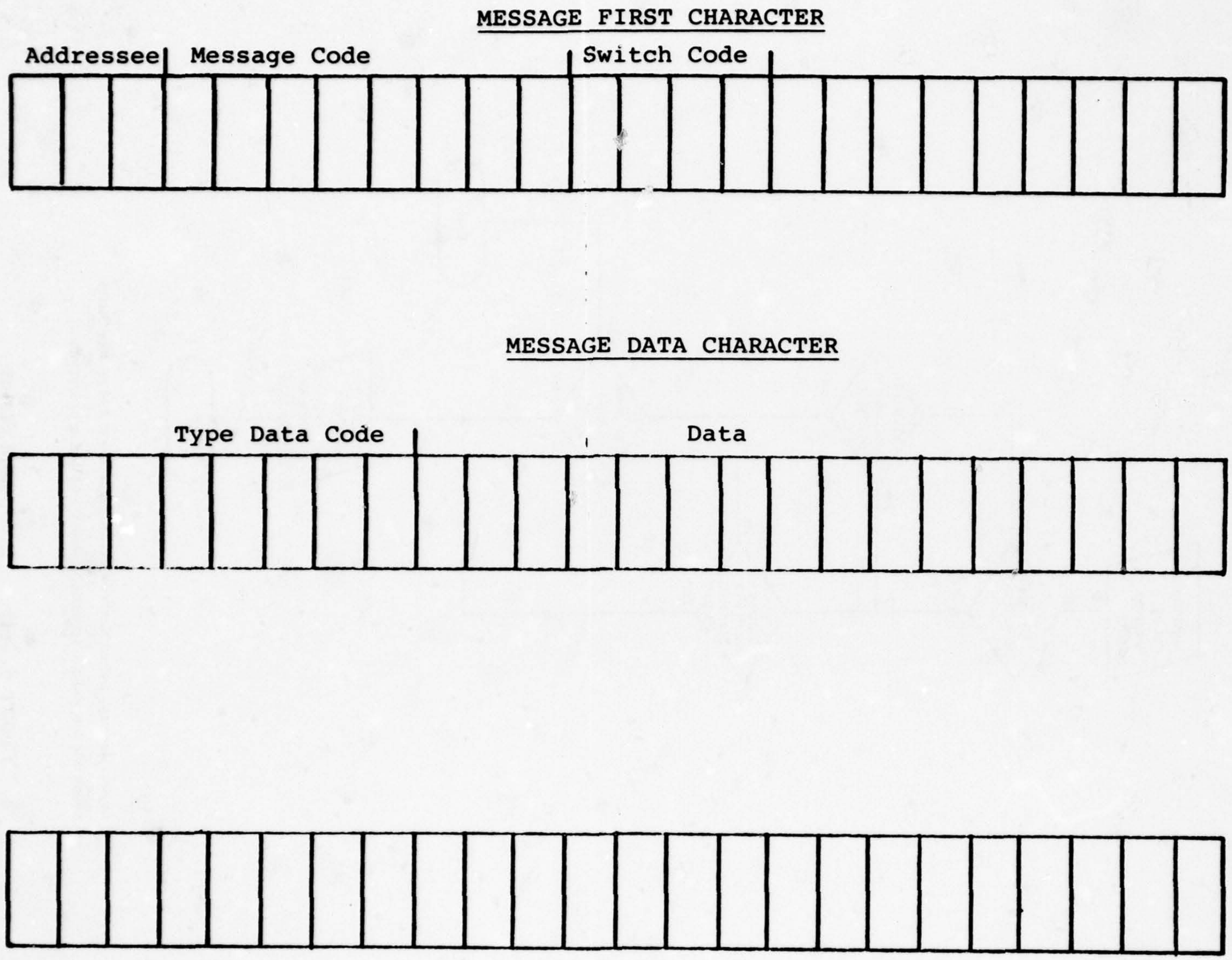


Figure 6.3-1. Message Structure

6.3.1 Input Sources

The automatic inputs to the AUTOVON ACOC module will be limited to the automatic inputs from each Node and AUTOVON switch station level module under ACOC control. Manual inputs to request or suppress displays and record control actions will be accepted.

6.3.2 Input Data

The input data at the ACOC level will consist of abnormal traffic or equipment conditions supplied from the Nodes and individual AUTOVON switch station level modules.

Currently, the inputs from the nodes are seen as trunk troubles reported to the Node by an AUTOVON switch station level module. Inputs from the AUTOVON switch station level modules which have been developed are listed with their message codes in Table 6.3-1. Additional inputs will be developed as the need is determined.

Each message will contain an addressee code, message code and transmitting switch code. Figure 6.3-1 illustrates the message structure. If the most significant digit of the message code is a "0", more data will follow. Each of the following data characters will consist of an 8-bit Type Data Code and up to 16 data bits. Suggested type data codes and data codes for use in data messages are included in Tables 6.3-2 through 6.3-9. The make up of messages as presently envisioned is included as Table 6.3-10.

6.3.3 ACOC Data Outputs and Displays

The AUTOVON module at the ACOC in conjunction with other related unified control modules should provide the network controllers with visibility of network operational conditions and status, traffic congestion, and allow for network control decisions and actions to be made and implemented on a timely basis. The initial correlation and display of data should be at a manageable level and expanded or reduced based on network operational experience over a period of use under all types of conditions. The following list of displays are considered adequate for initial implementation.

6.3.3.1 Required Outputs

The list of switch conditions providing visibility should be displayed to the network controller as follows:

- Equipment Status - Logics Out-of-Service
  Memory Out-of-Service
  Markers Out-of-Service

  These items are to be displayed only if call processing is adversely affected.

- Traffic Overloads - All trunks busy, tandem blockage, precedence blockage, etc. To be displayed if system congestion appears imminent.

- All calls routed by ATPC Plan #2 if the plan has not been ordered by the ACOC controller.

- Originating and terminating line or trunk circuit problems affecting special interest circuits

- Summaries of any additional stored information on manual request

Decisions resulting from analysis of abnormal conditions should provide the network controller with the following suggested control actions:

- Implementation of Line Load Control A, B, or C.

- Implementation of alternate routing decks (Red Decks) to circumvent a transmission system that is inoperative

- Implementation of directionalization and identification of trunk or trunk group requiring that action.

- Implementation of ATPC Plans #1 or #2 and dialed codes requiring that action.

6.3.3.2 Flowcharts

The flowcharts developing the AUTOVON ACOC level module functions are described in the following paragraphs.

TABLE 6.3-1. Message Codes (Sheet 1 of 2)

00000001	(1)	Terminating Trunk Trouble (Trunk Identities)
00000010	(2)	Originating Trunk Trouble (Trunk Identities)
00000011	(3)	DCX-9 Overload (Trunk Identities
00000100	(4)	Degraded Call Processing Efficiency (By Register Junctor)
00000101	(5)	Manually Requested Register Junctor Call Processing Efficiency
10000110	(6)	TCMF Receiver Overload on detection of Degraded Switch Call Processing Efficiency
10000111	(7)	MF 2/6 Transceiver Overload on detection of Degraded Switch Call Processing Efficiency
10001000	(8)	ATOP and Call Processing Efficiency Invalid
10001001	(9)	Line Load Control A and Call Processing Efficiency Invalid
10001010	(10)	Line Load Control B and Call Processing Efficiency Invalid
10001011	(11)	Line Load Control C and Call Processing Efficiency Invalid
10001100	(12)	All Registers Busy
10001101	(13)	ATOP Switch Setting Incorrect
00001110	(14)	Number and Percent of Register Junctors Maintenance Busy on Threshold of Register Junctors Busy
00001111	(15)	Number and Percent of TCMF Receivers Maintenance Busy on Threshold of TCMF Receivers Busy
00010000	(16)	Number and Percent of MF 2/6 Transceivers Maintenance Busy on Threshold of MF 2/6 Transceivers Busy
00010001	(17)	Pool Equipment Status in Reply to Manual Request
10010010	(18)	Assigner Problem and Degraded Call Processing Efficiency
00010011	(19)	Degraded Call Processing Efficiency (By Switch)

Table 6.3-1. Message Codes (Sheet 2 of 2)

00010100	(20)	Manually Requested Switch Call Processing Efficiency)
00010101	(21)	Too Many Calls Being Alternated Routed From This Switch (This Switch Identity) to (Connecting Switch Identity) and (NNX or NYX Codes Affected)
00010110	(22)	ATB and Receiving too Many Calls from (Connecting Switch Identity)
00010111	(23)	Immediate Precedence Blockage Terminating to a PBX (PBX Identity)
00011000	(24)	Immediate Precedence Blockage - Tandem Traffic (Originating Trunk Group and Terminating Trunk Group) and affected NNX or NYX Codes
00011001	(25)	Excessive number of calls being routed to ____ NNX/NYX Codes on _____Trunk Group
00011010	(26)	Overload in first tandem Switch on route of NNX/NYX Code reported.
00011011	(27)	ATPC plan #2 for NNX/NYX Code reported accessed at reporting switch.
00011100	(28)	Equipment out of service status summary (on detection of degraded call processing efficiency)
00011101	(29)	Equipment status summary (Reply to manual request)
00011110	(30)	All trunks busy on reported trunk group
00011111	(31)	General data report/request
00100000	(32)	Trunk Group busy/idle status summary
00100001	(33)	Busy Idle Status

TABLE 6.3-2. Type Data Codes (Sheet 1 of 2)

00000001	(1)	Originating Trunk or Trunk Group
00000010	(2)	Terminating Trunk or Trunk Group
00000011	(3)	Call Processing Efficiency and Register Junctor Number
00000100	(4)	Switch Call Processing Efficiency
00000101	(5)	TCMF or MF 2/6 Equipment Identity
00000110	(6)	Register Junctor Total and Percent
00000111	(7)	TCMF Receiver Total and Percent
00001000	(8)	MF 2/6 Transceiver Total and Percent
00001001	(9)	This Switch Identity
00001010	(10)	Connecting Switch Identity
00001011	(11)	NNX or NYX Code
00001100	(12)	Register Junctor 1-8 Busy/Maint. Busy Status
00001101	(13)	Register Junctor 9-16 Busy/Maint. Busy Status
00001110	(14)	Register Junctor 17-24 Busy/Maint. Busy Status
00001111	(15)	TCMF 1-15 Service Busy Status
00010000	(16)	TCMF 1-15 Maint. Busy Status
00010001	(17)	MF 2/6 1-15 Service Busy Status
00010010	(18)	MF 2/6 1-15 Maint. Busy Status
00010011	(19)	Logic, Memory, Marker Out of Service Status
00010100	(20)	Trunk/Trunk Group
00010101	(21)	PBX Code

Table 6.3-2. Type Data Codes (Sheet 2 of 2)

00010110	(22)	Time "Hour"
00010111	(23)	Time "Minute and Second"
00011000	(24)	Busy Idle Status Summary. Trunk Group ID Flash Override and Flash Count
00011010	(25)	Busy Idle Status Summary Immediate, Priority and Routine Count
0011011	(26)	Busy/Idle Indicator
1000001	(27)	Special Interest Originating Trunk or Trunk Group
1000010	(28)	Special Interest Terminating Trunk or Trunk Group

TABLE 6.3-3. Reporting and Connecting Switch Codes

Code	Switch
0000	Clark (CLK)
0001	Coltano (CTO)
0010	Corozal (CZL)
0011	Donnersberg (DON)
0100	Feldberg (FEL)
0101	Finegayan (FGB)
0110	Fort Buckner (FTB)
0111	Fuchu (FUU)
1000	Hillingdon (HIN)
1001	Humosa (HUM)
1010	Langerkopf (LKF)
1011	Martlesham Heath (MAM)
1100	Mount Pateras (MTP)
1101	Mount Vergine (MTV)
1110	Schoenfeld (SCH)
1111	Wahiawa (WHW)

TABLE 6.3-4. Register Junctor (RJ) Number Codes

CODE	RJ NUMBER
00001	1
00010	2
00011	3
00100	4
00101	5
00110	6
00111	7
01000	8
01001	9
01010	10
01011	11
01100	12
01101	13
01110	14
01111	15
10000	16
10001	17
10010	18
10011	19
10100	20
10101	21
10110	22
10111	23
11000	24

TABLE 6.3-5. Touch Call Multifrequency (TCMF)/Multifrequency (MF) Number

CODE	TCMF/MF NUMBER
*0001	1
*0010	2
*0011	3
*0100	4
*0101	5
*0110	6
*0111	7
*1000	8
*1001	9
*1010	10
*1011	11
*1100	12
*1101	13
*1110	14
*1111	15

*MSD can be "0" or "1"   0 = MF   1 = TCMF

TABLE 6.3-6. TRUNK, NNX/NYX CODES

ORIGINATING TRUNK/TERMINATING TRUNK CODES

Code	Trunk ID*
0000 0000 0000 0000	0000
0000 0000 0000 0001	0001
Thru	
1001 1001 1001 1001	9999

* Trunk ID is a 4-digit code-All Digits can have the value "0" thru "9".

NYX/NNX CODES

NYX

Code	Value*
0010 0000 0000	200
Thru	
1001 0001 1001	919

* - First Digit of NYX code can be any digit "2" thru "9"
- Second Digit of NYX Code can be digits "0" or "1" only
- Third Digit of NYX Code can be any digit "0" thru "9"

NNX

Code	Value*
0010 0010 0000	220
thru	
1001 1001 1001	999

* - First and Second digit of NNX code can be any digit "2" thru "9"
- Third digit of NNX code can be any digit "0" thru "9"

TABLE 6.3-7. **Call Processing Efficiency, PABX/PBX, Busy Idle Indicator Codes**

SWITCH OR JUNCTOR CALL PROCESSING EFFICIENCY CODES

Code	% Efficiency
0 0000 0000	0
thru	
1 0000 0000	100

PRIVATE AUTOMATIC OR PRIVATE BRANCH EXCHANGE (PABX/PBX) IDENTITY CODES

Code	PABX/PBX
000001	1*
thru	
111111	63*

*PABX/PABX name to be assigned later.

BUSY IDLE INDICATOR CODES

Code	Busy/Idle Indicator
0000	Originating Busy
0001	Flash Precedence
0010	Immediate Precedence
0011	Priority Precedence
0100	Routine Busy
1001	Queueing Idle
1101	True Idle
1110	Maintenance Busy
1111	Unequipped

TABLE 6.3-8. Addressee Codes

Code	Addressee
001	Diagnostic Processor
010	Node
100	ACOC
011	Diagnostic Processor and Node
110	ACOC and Node
111	Diagnostic Processor, Node, and ACOC

TABLE 6.3-9. ACOC Manual AUTOVON Data Requests

REQUEST NUMBER	REQUEST TYPES
5 (00000101)	Register Junctor Call Processing Efficiency Request
17 (00010001)	Pool Equipment Status Request
20 (00010100)	Switch Call Processing Efficiency Request
29 (00011101)	Equipment Status Request
31 (00011111)	General Data Request*

* Manual or Automatic

TABLE 6.3-10. Possible Combination of Message and Data Types (Sheet 1 of 2)

MESSAGE TYPE		DATA TYPES INCLUDED
00000001	(1)	00000010, 00010110, 00010111 or 10000010, 00010110, 00010111
00000010	(2)	00000001, 00010110, 00010111 or 10000001, 00010110, 00010111
00000011	(3)	00000001*, 00010110, 00010111
00000100	(4)	00000011*, 00010110, 00010111
00000101	(5)	00000011, 00010110, 00010111
00001110	(14)	00000110, 00010110, 00010111
00001111	(15)	00000111, 00010110, 00010111
00010000	(16)	00001000, 00010110, 00010111
00010001	(17)	00001100, 00001101, 00001110, 00001111, 00010000, 00010001, 00010010, 00010110, 00010111
00010011	(19)	00000100, 00010110, 00010111
00010100	(20)	00000100, 00010110, 00010111
00010101	(21)	00001001, 00001010, 00001011*, 00010110, 00010111
00010110	(22)	00001010, 00010110, 00010111
00010111	(23)	00010101, 00001011*, 00010110, 00010111, 00000010
00011000	(24)	00000001, 00000010, 00010110, 00010111
00011001	(25)	00000001, 00000010, 00010110, 00010111
00011010	(26)	00001010, 00001011*, 00010110, 00010111
00011011	(27)	00001011, 00010110, 00010111
00011100	(28)	00010011, 00010110, 00010111

Table 6.3-10. Possible Combination of Message and Data Types (Sheet 2 of 2)

MESSAGE TYPE		DATA TYPES INCLUDED
00011101	(29)	00010011, 00010110, 00010111
00011110	(30)	00010100, 00010110, 00010111 and 00010101, or 00001010
00011111	(31)	Data Type Required by Request
00100000	(32)	00011000, 00011001
00100001	(33)	00010100, 00011011, 00010111, 00010111

*Multiple Characters of this Data Type are Possible in These Messages

6.3.3.2.1 AUTOVON Traffic Processor

The ACOC AUTOVON traffic processor, shown in Figure 6.3-2, consists of 17 subroutines to accept data messages from the switches. This algorithm will determine the message type and data types within each message. If a message contains incorrect data type(s), a branch will be made to an error subroutine. After an incoming message is determined to be correct, it will be loaded into the appropriate section of temporary storage to await processing by the ACOC AUTOVON traffic data correlation processor.

6.3.3.2.2 AUTOVON Traffic Data Correlation Processor

The ACOC AUTOVON traffic data correlation processor, Figure 6.3-3, consists of two sections. They are the overall AUTOVON manager which serves as an index for data from the AUTOVON switches input storage and the Processing and Display section.

a. The Overall Manager section samples a register containing the message types presently stored in input storage, and directs the program to the subroutine that processes the data stored with the appropriate message for display, or display of suggested control actions. The priority suggested by the flowchart is not absolute, and housekeeping functions, such as erasing the message type after reading it are eliminated.

b. The Processing and Display sections is broken down into thirty three subroutines, each associated with a particular input message type. They are individually explained below:

   (1) A - Terminating Trunk Troubles (Sheet 3). These are terminating trunk troubles which were reported to a node by an AUTOVON Switch Level Module. As the trouble report is read, the ACOC data base is checked to see if any other troubles have been reported on that trunk. If not, a trouble register with time notation is started. If another trouble has been reported, the trunk's trouble register is incremented and the trouble time is recorded. A calculation is then made to determine the ratio of the number of trouble reports to elapsed time (time computed in hours).

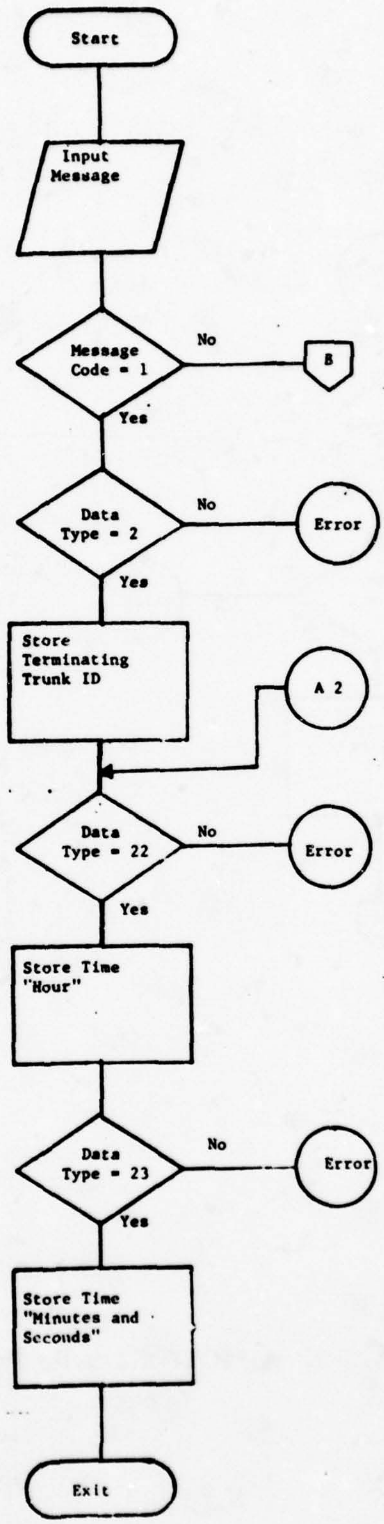


Figure 6.3-2. AUTOVON Traffic Processor (Sheet 1 of 8)

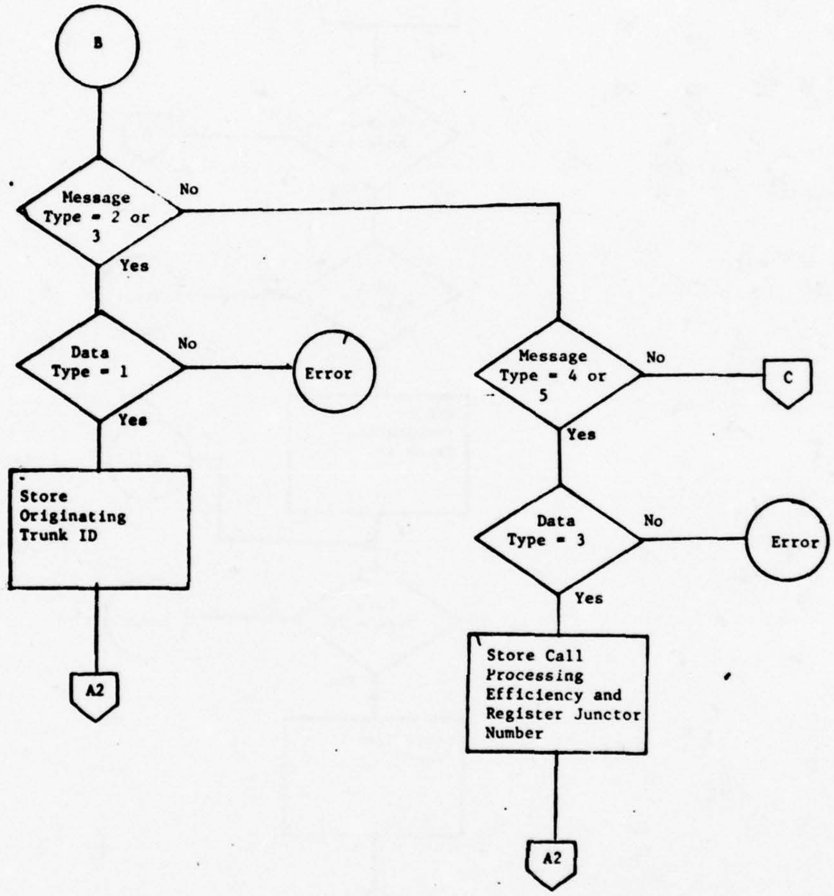


Figure 6.3-2. AUTOVON Traffic Processor (Sheet 2 of 8)

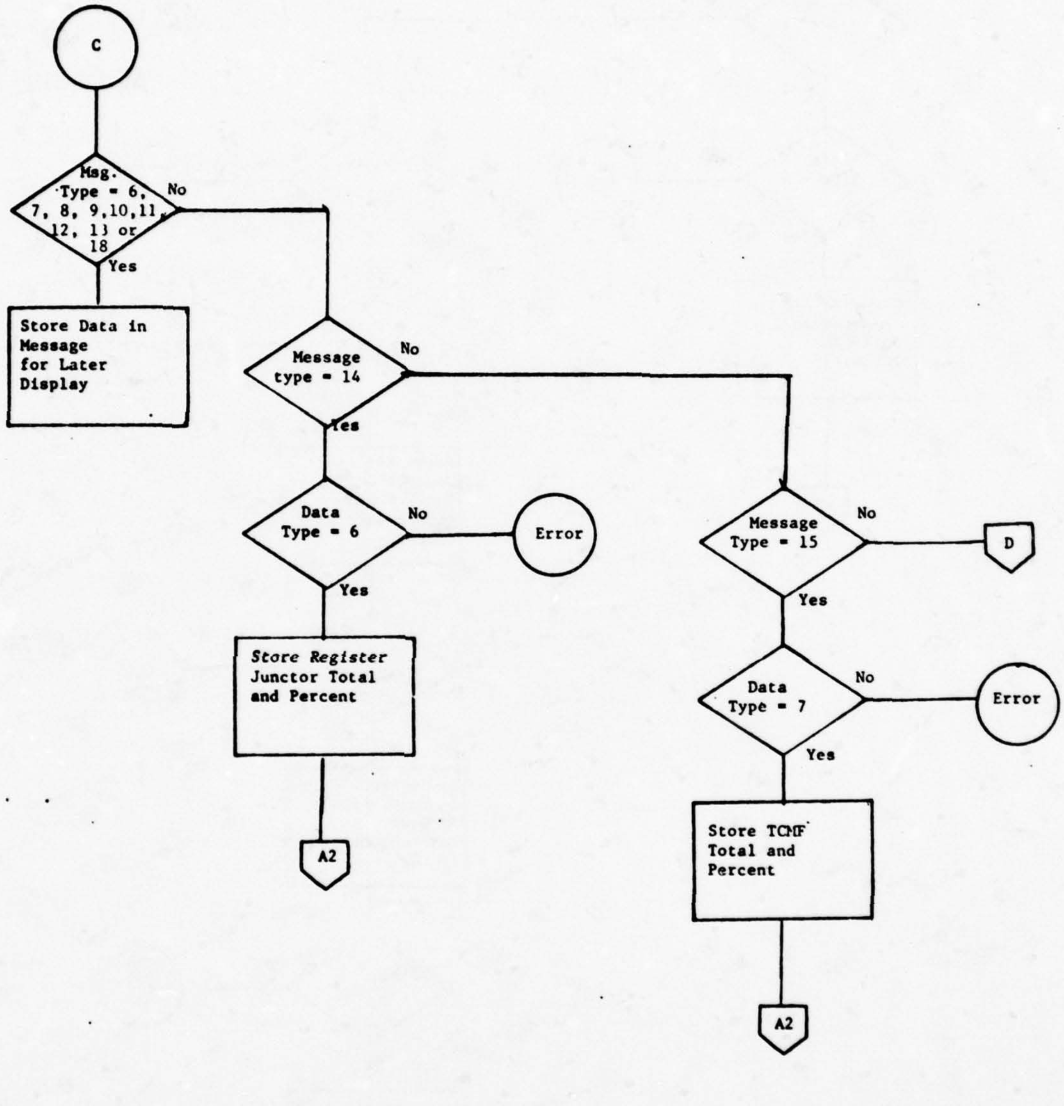


Figure 6.3-2. AUTOVON Traffic Processor (Sheet 3 of 8)

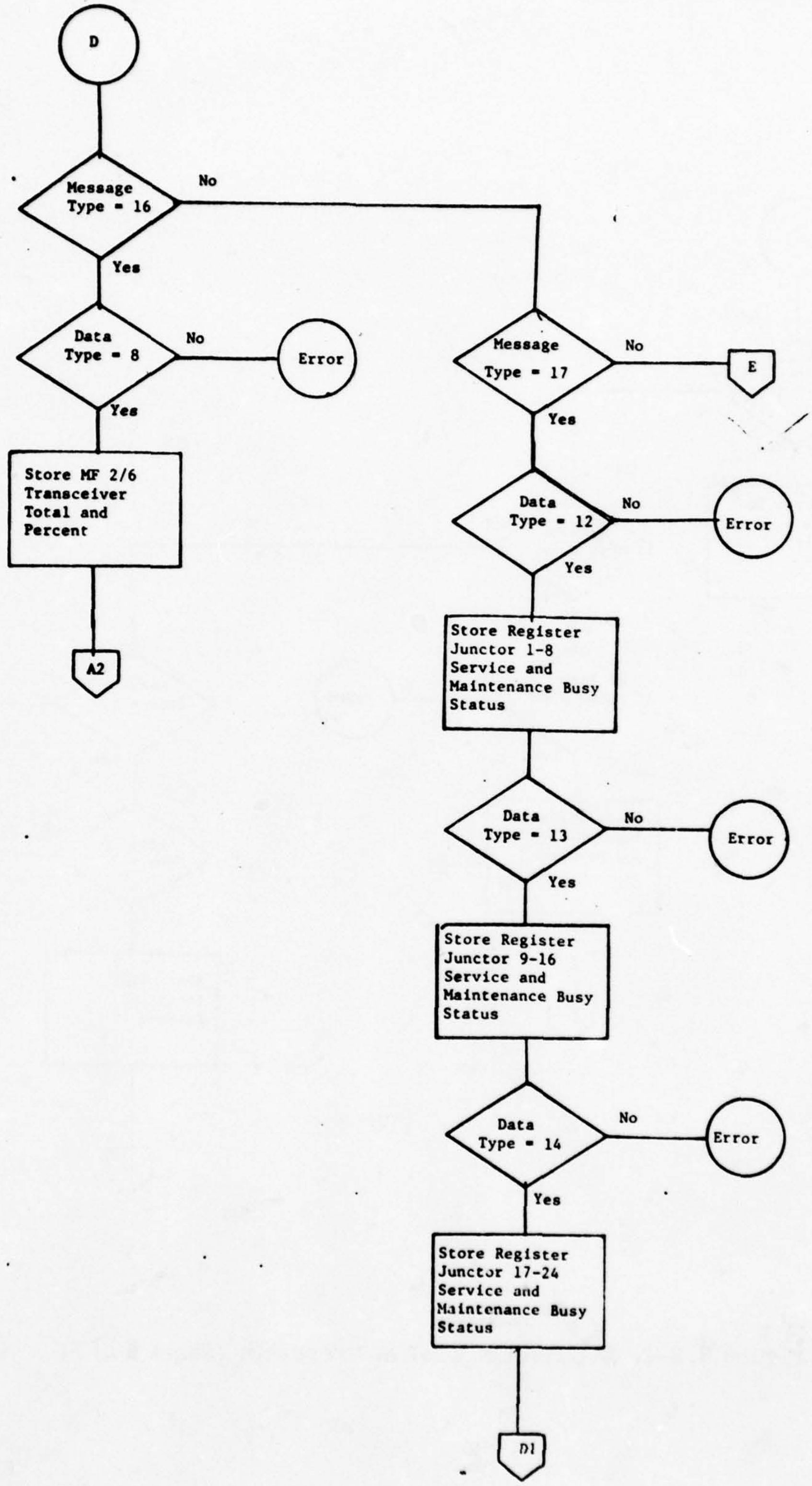


Figure 6.3-2. AUTOVON Traffic Processor (Sheet 4 of 8)

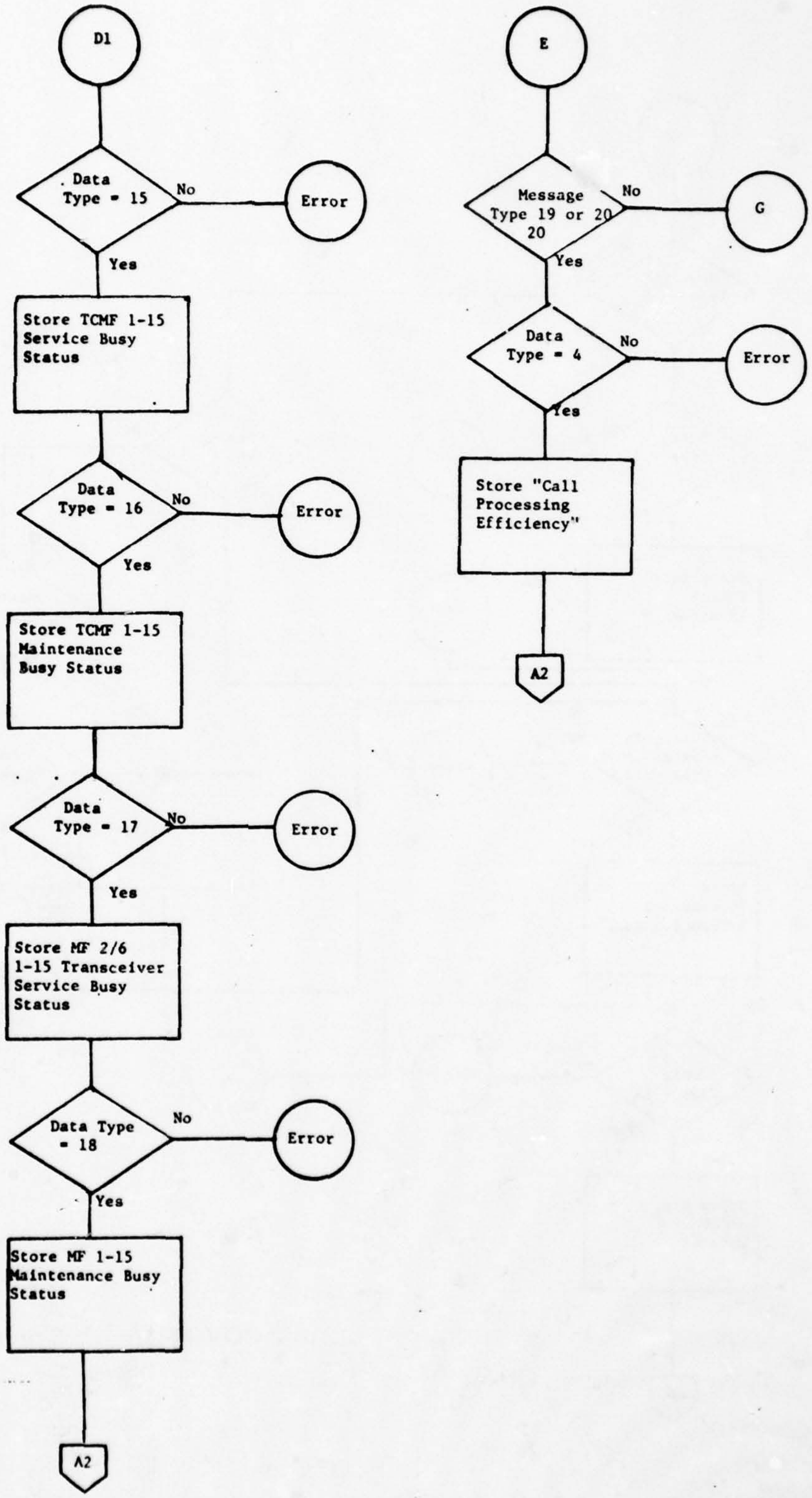


Figure 6.3-2. AUTOVON Traffic Processor (Sheet 5 of 8)

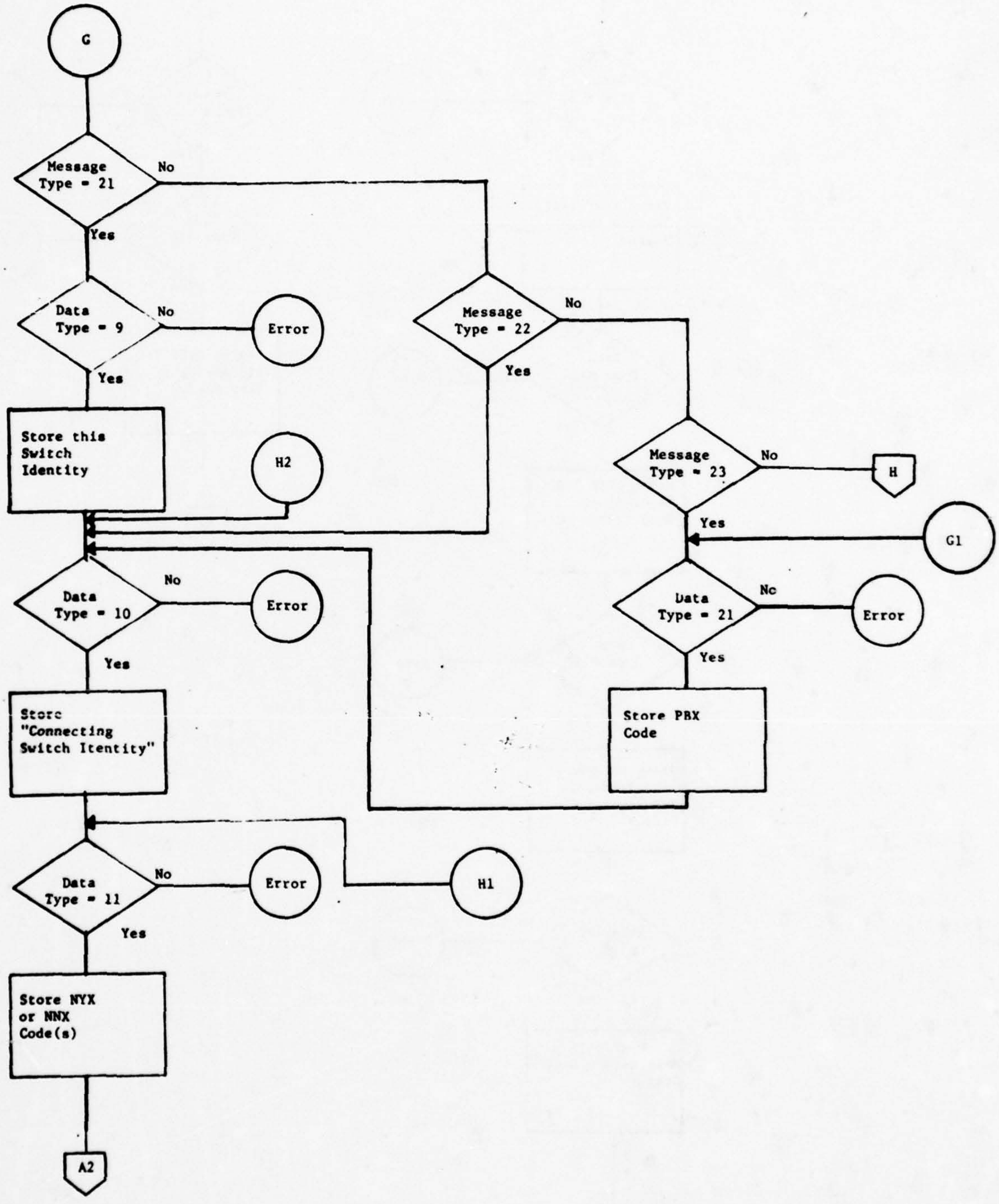


Figure 6.3-2. AUTOVON Traffic Processor (Sheet 6 of 8)

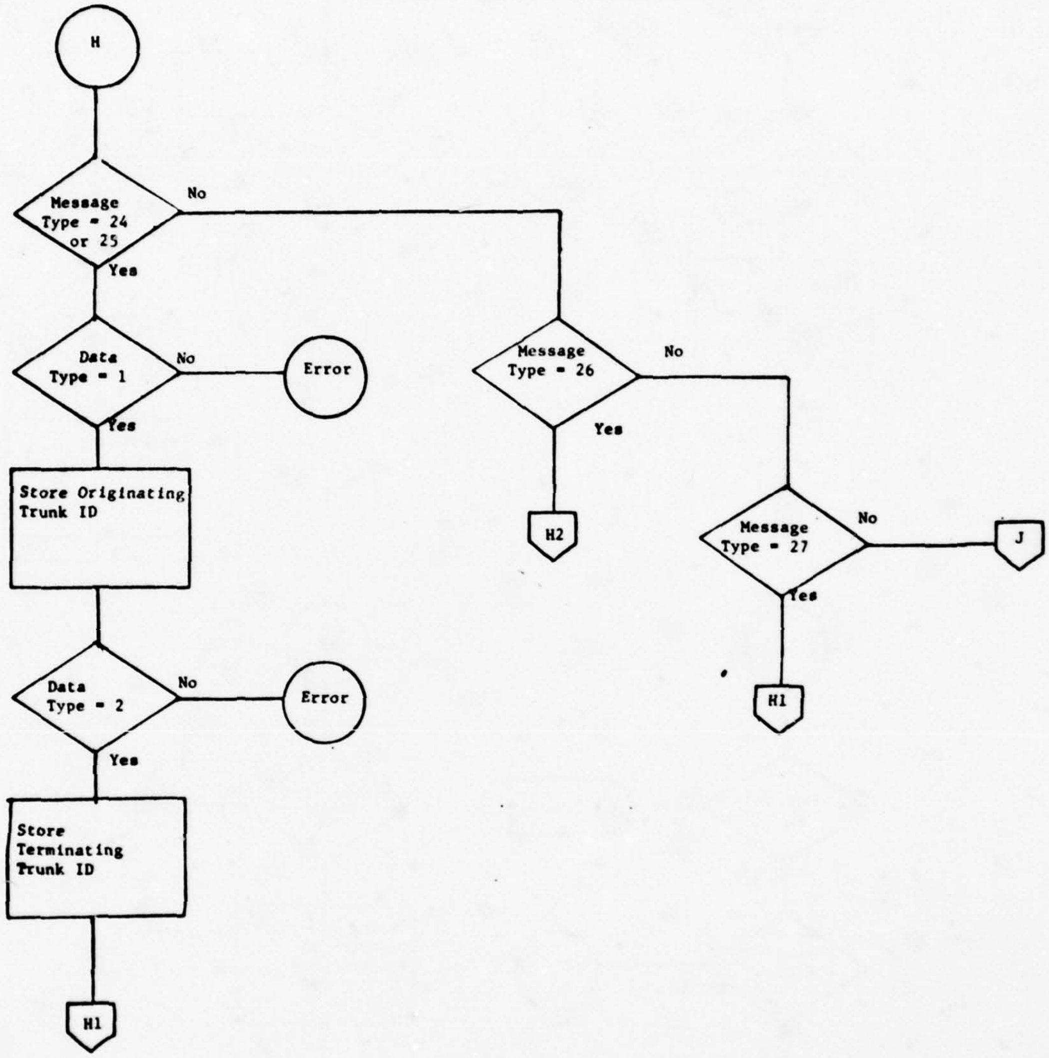


Figure 6.3-2. AUTOVON Traffic Processor (Sheet 7 of 8)

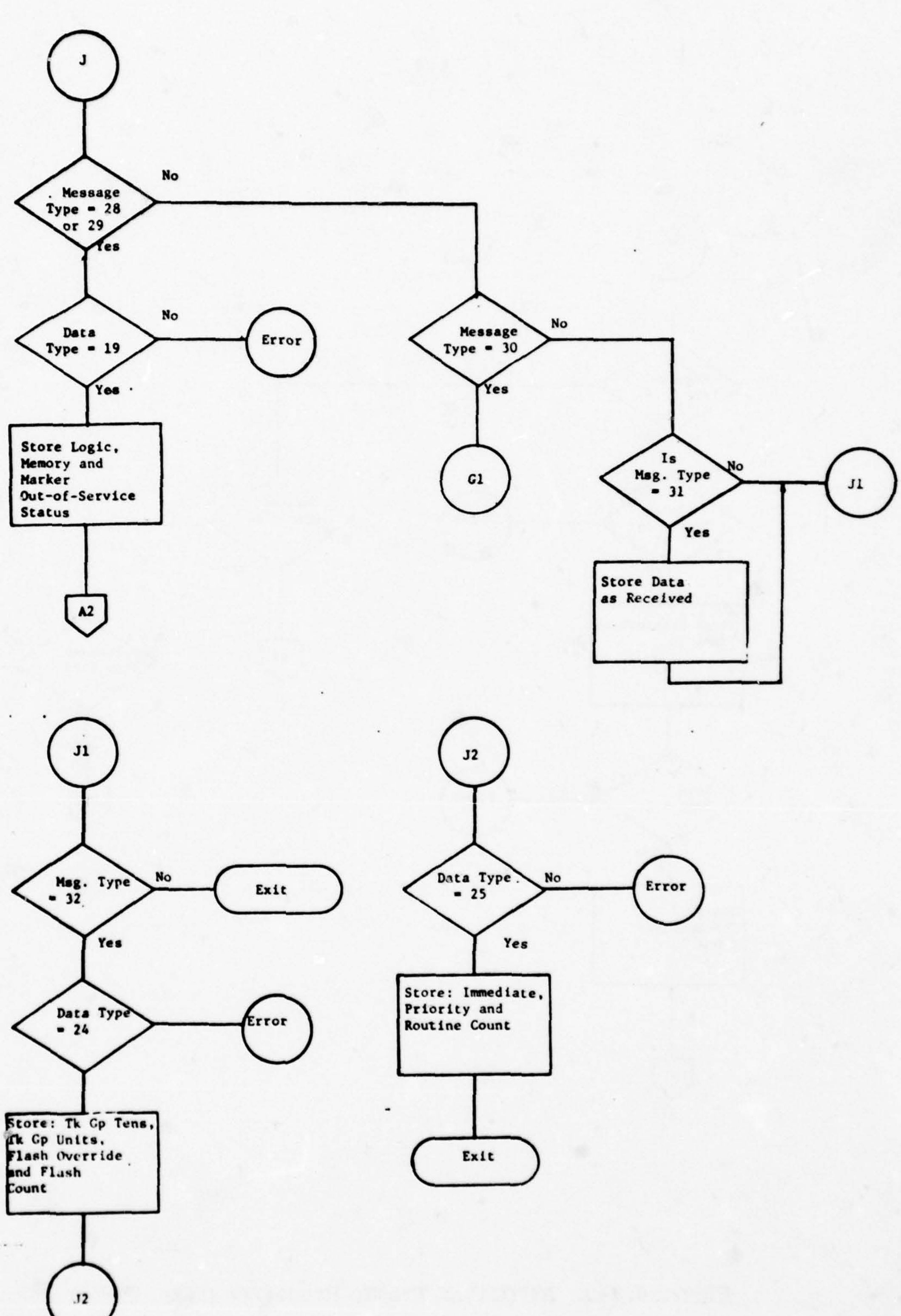


Figure 6.3-2. AUTOVON Traffic Processor (Sheet 8 of 8)

The normal traffic density for the last reported time is determined, simply by asking if traffic at the reporting time is normally heavy. If so, a high ratio of trouble per time will be tolerated, if not, a very low ratio of troubles per time will be tolerated. If either tolerable threshold is exceeded, a message is generated to the appropriate switches logging the circuit inoperative and requiring the circuit to be made maintenance busy at both ends.

(2) B - Originating Trunk Trouble (Sheet 4). These are originating trunk troubles which are reported to a node by an AUTOVON Switch Level Module. As the trouble report is read, the ACOC data base is checked to see if any other troubles have been reported on that trunk. If not, a trouble register (to be shared by the terminating trouble reports) is started for this trunk. If another trouble has been reported, the trunk's trouble register is incremented.

No circuit is logged out of service because of originating problems alone; however, if a combination of originating and terminating troubles exceeds the threshold on Sheet 3, appropriate action is taken to log the circuit out of service.

(3) C - DCX-9 Overload (Sheet 4). This type message is processed on an originating trunk trouble for each circuit involved.

(4) D - Degraded Register Junctor Call Processing Efficiency (Sheet 4). These are troubles indicating a Register Junctor is unable to properly process over 90 percent of the calls attempted. The report has been displayed at the switch and is forwarded to the ACOC.

Upon reading the data received with this report, a determination of the overall switch call processing efficiency of the applicable switch is made. If the switch's overall call processing efficiency is degraded below 90 percent (message type 19), the Register Junctor number along with its percent call processing efficiency is also displayed. If the switch's overall call processing efficiency is not degraded below 90 percent, display of this report is suppressed.

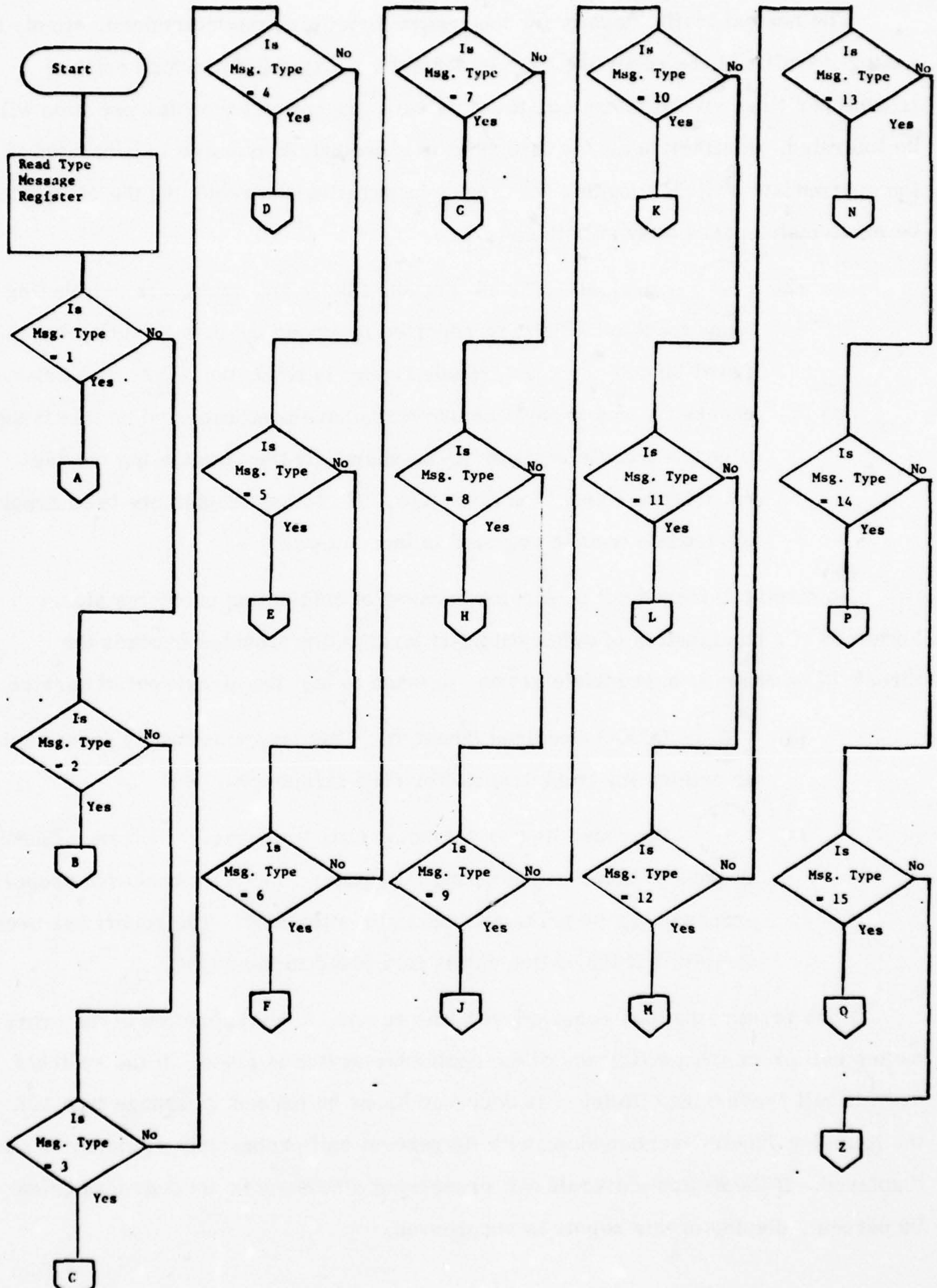


Figure 6.3-3. AUTOVON Traffic Data Correlation Processor (Sheet 1 of 15)

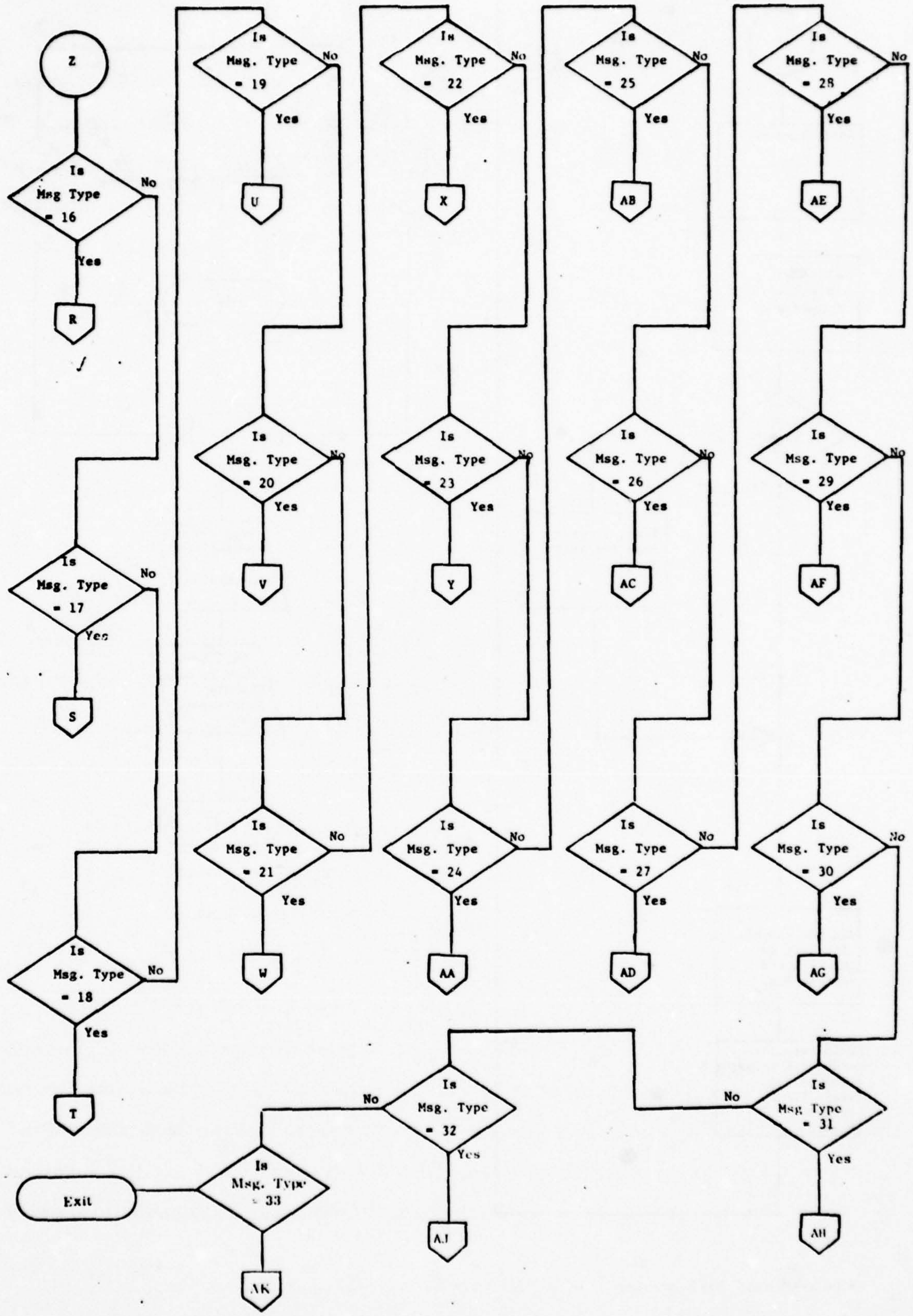
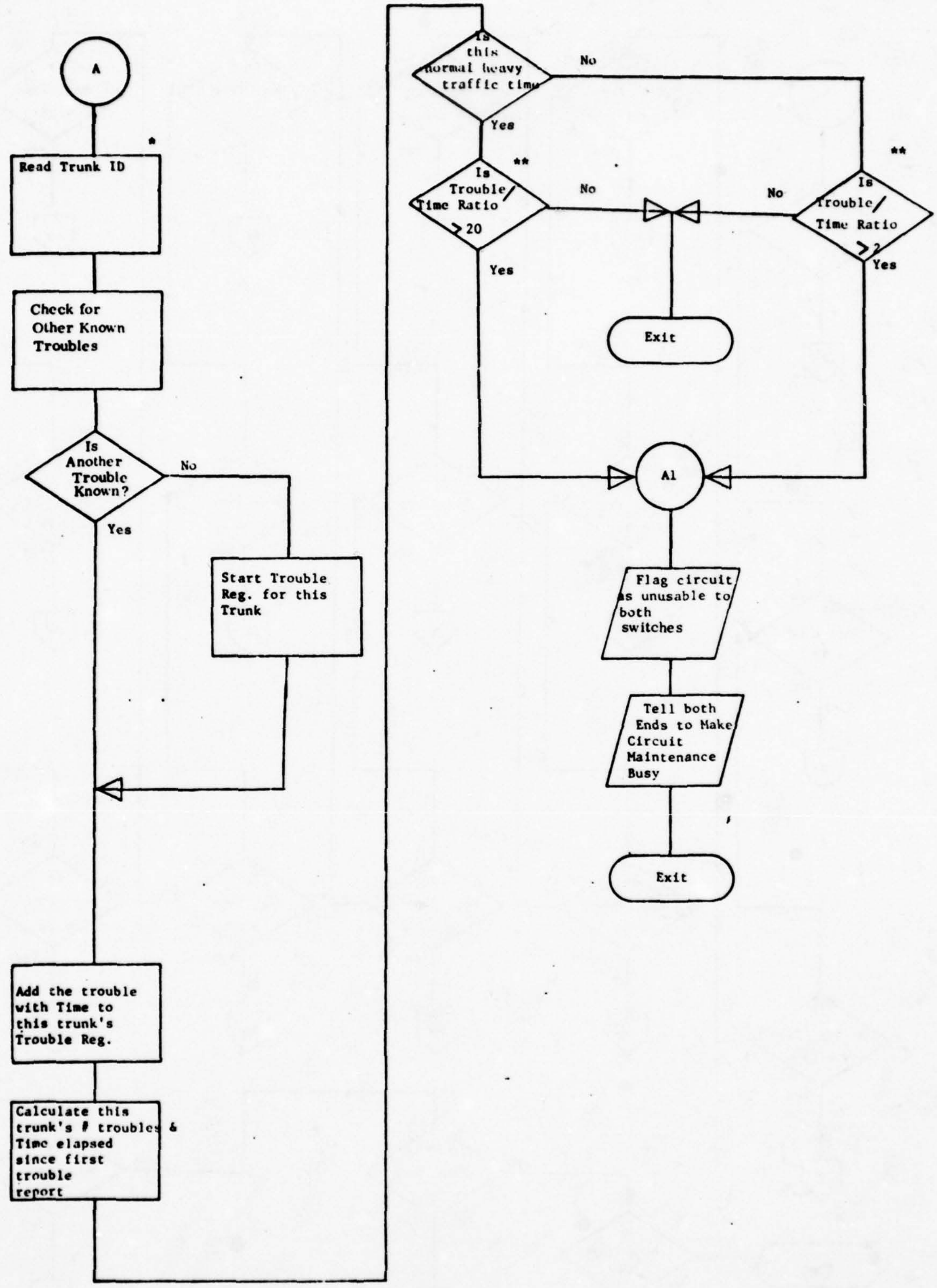


Figure 6.3-3. AUTOVON Traffic Data Correlation Processor (Sheet 2 of 15)



* Uncorrelatable Trunk problems reported by AUTOVON Switch Station Level [illegible]

** Values may be [illegible]

Figure 6.3-3. AUTOVON Traffic Data Correlation Processor (Sheet 3 of 15)

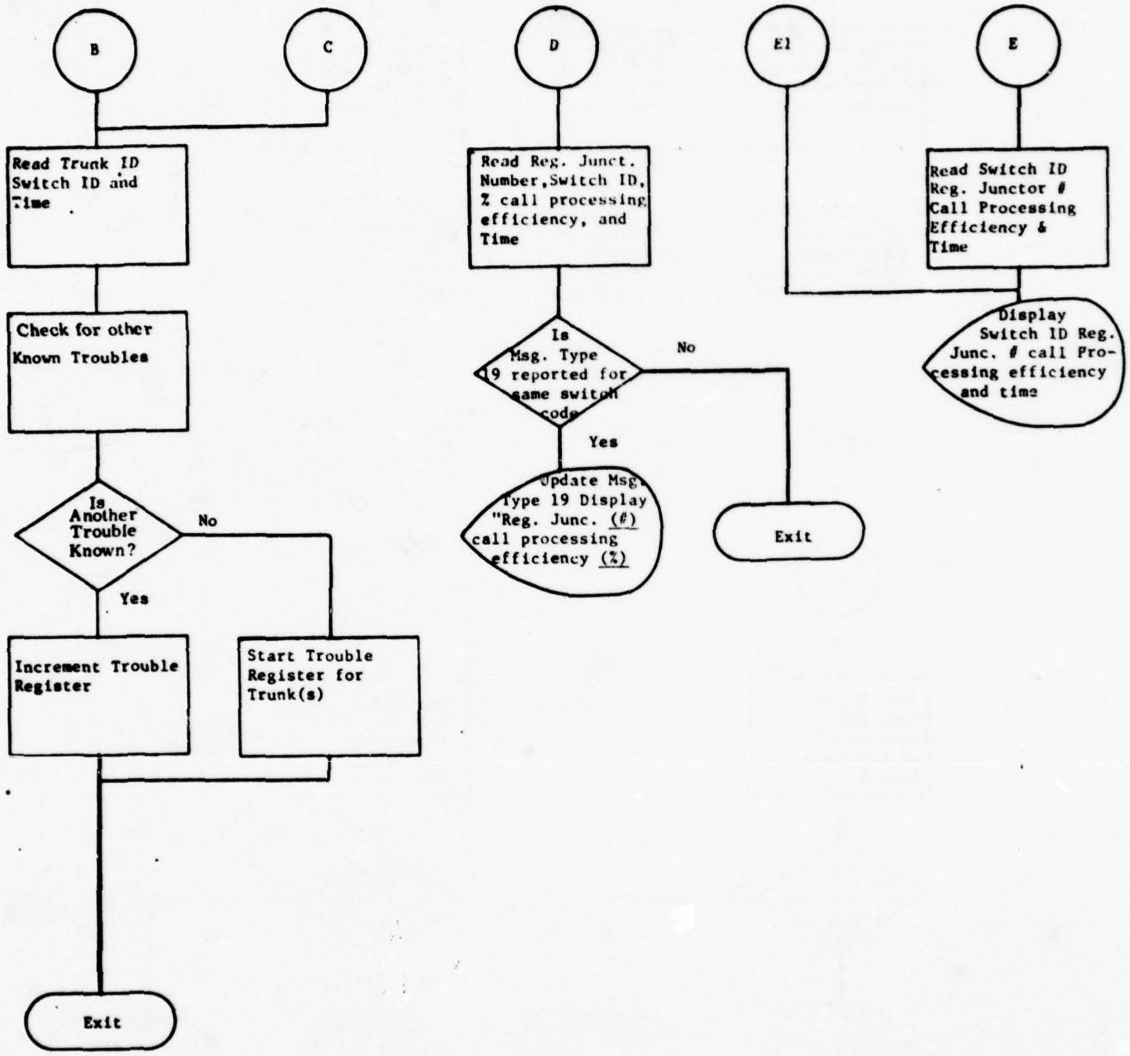


Figure 6.3-3. AUTOVON Traffic Data Correlation Processor (Sheet 4 of 15)

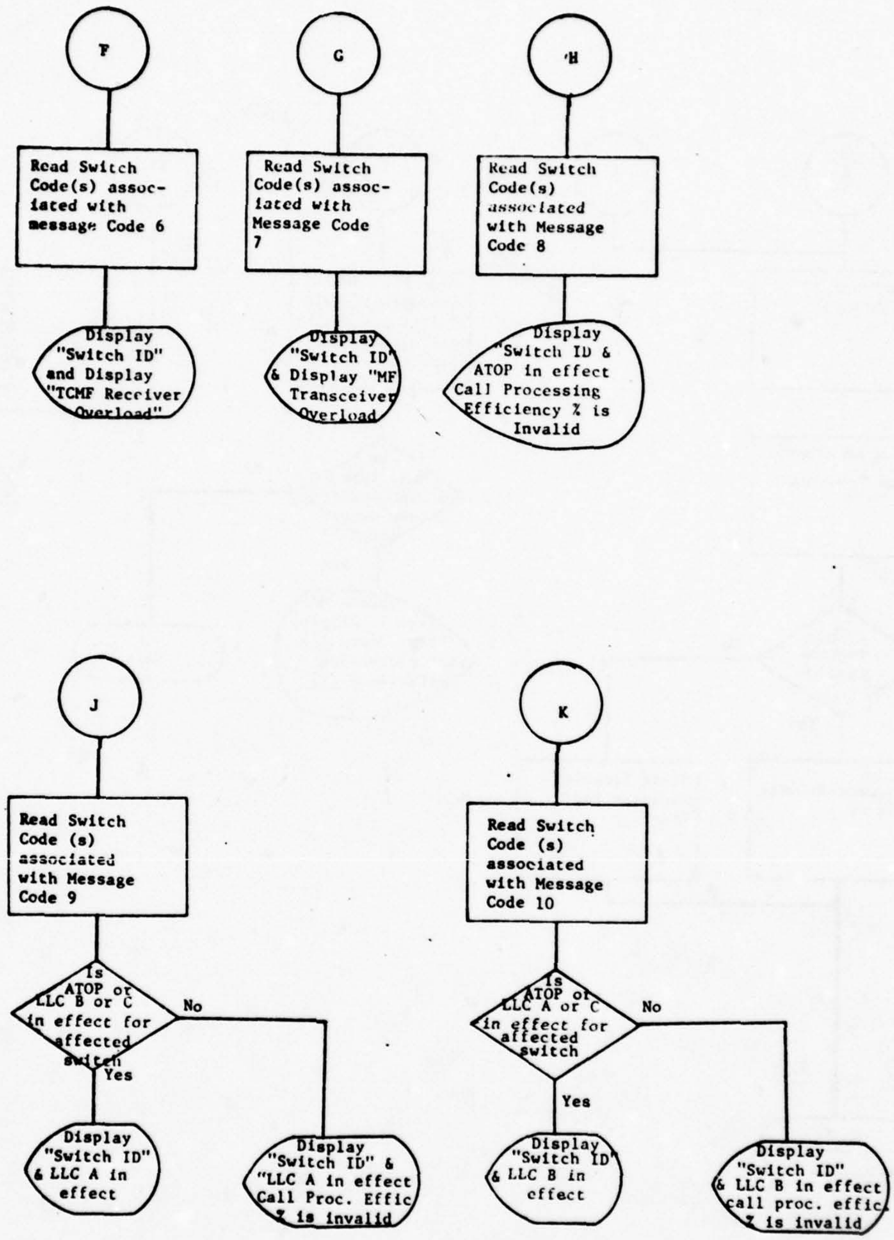


Figure 6.3-3. AUTOVON Traffic Data Correlation Processor (Sheet 5 of 15)

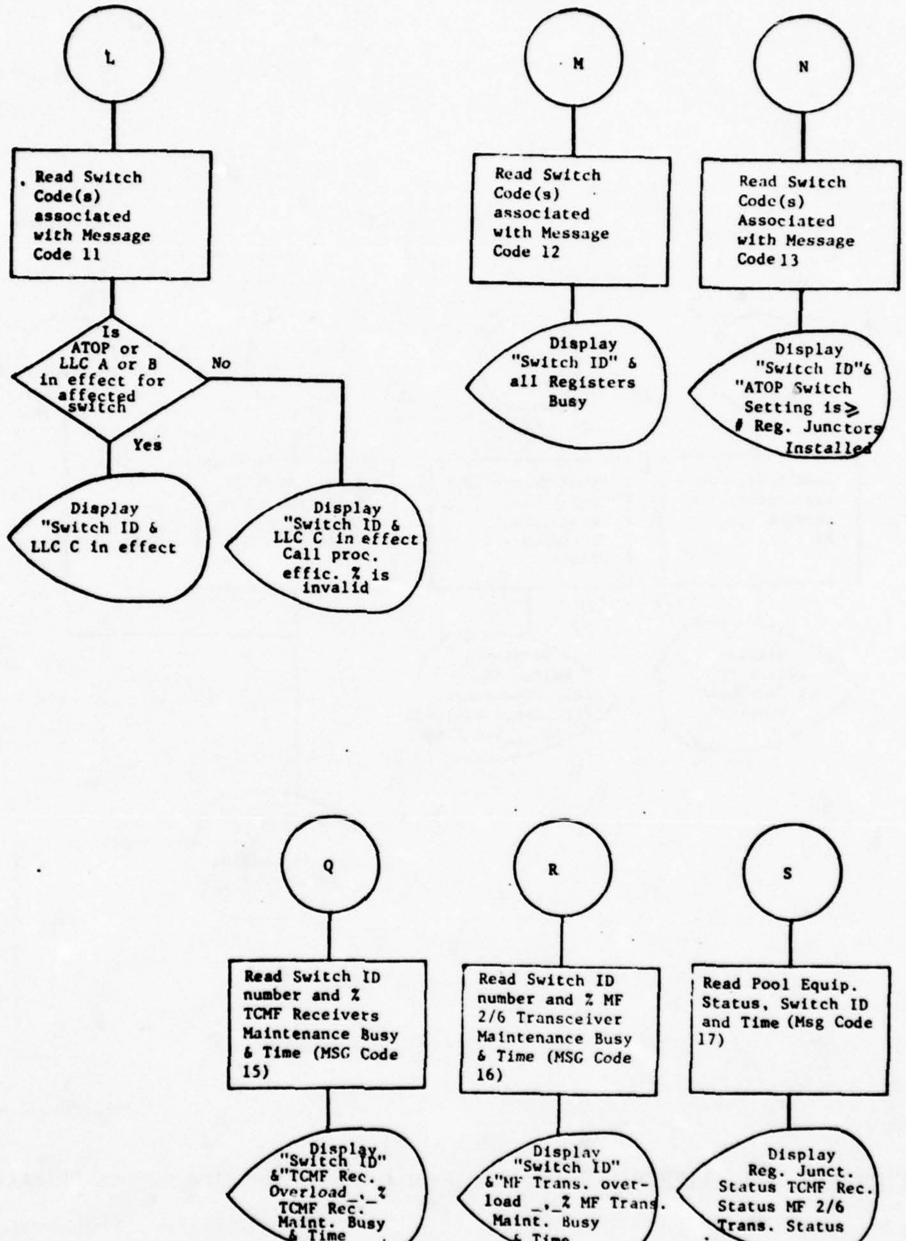


Figure 6.3-3. AUTOVON Traffic Data Correlation Processor (Sheet 6 of 15)

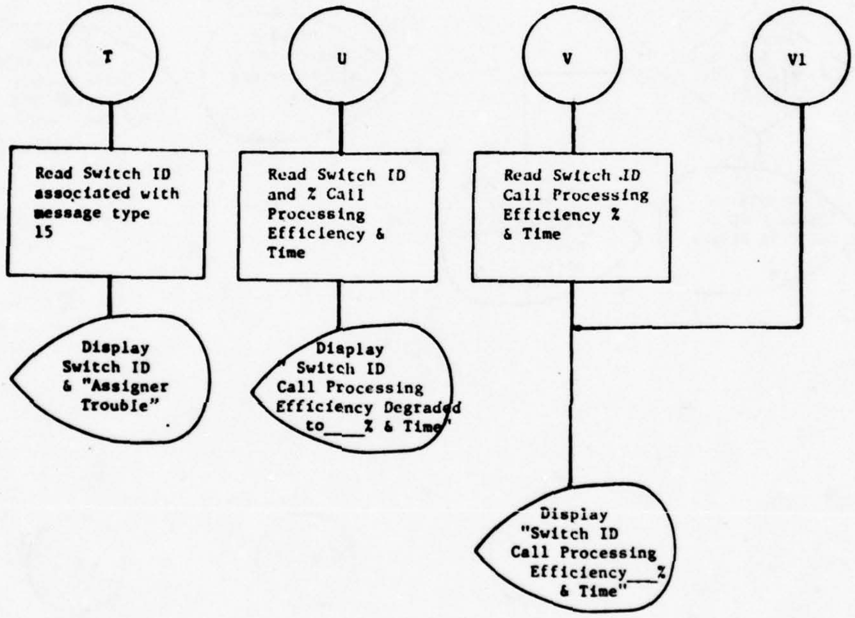


Figure 6.3-3. AUTOVON Traffic Data Correlation Processor (Sheet 7 of 15)

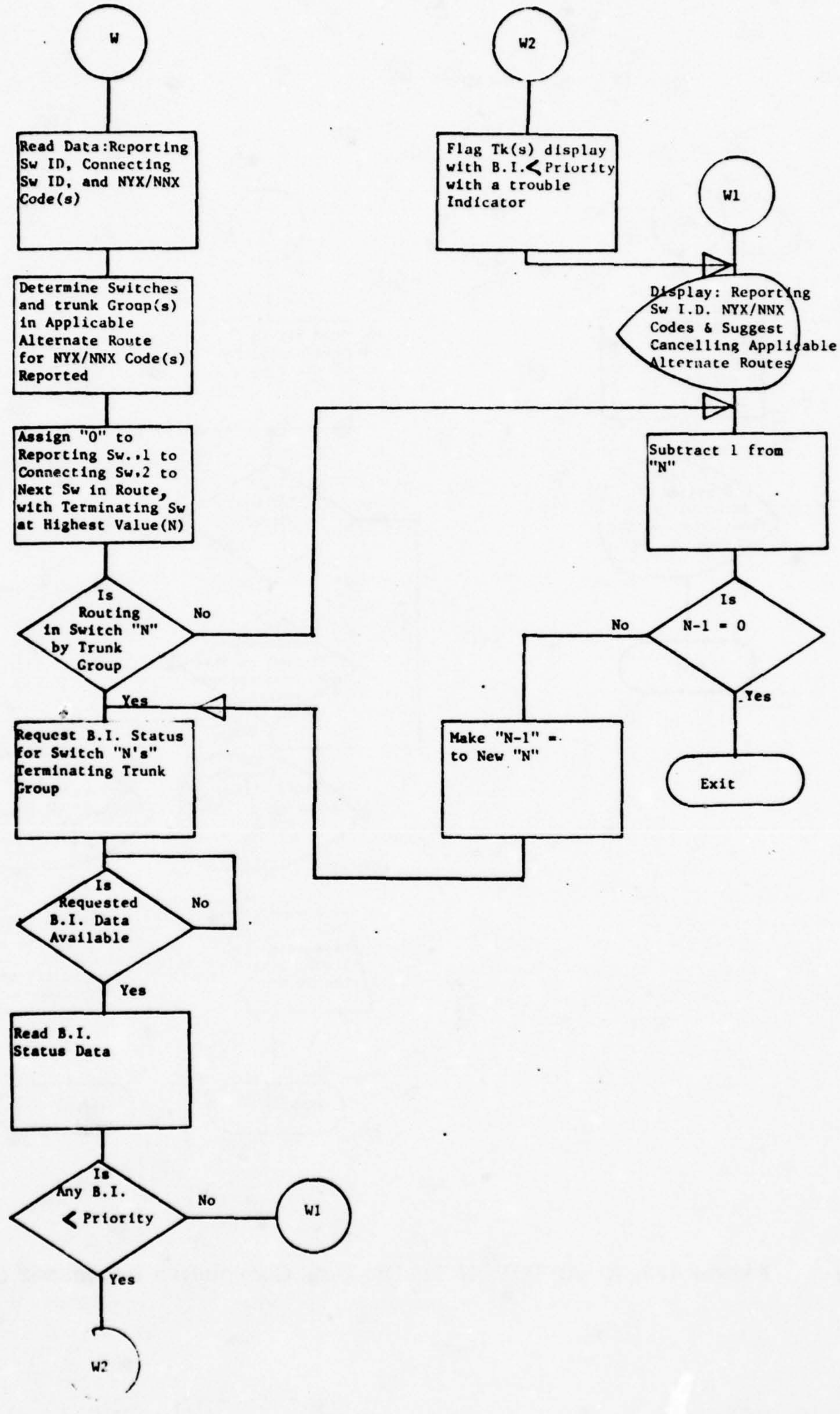


Figure 6.3-3. AUTOVON Traffic Data Correlation Processor (Sheet 8 of 15)

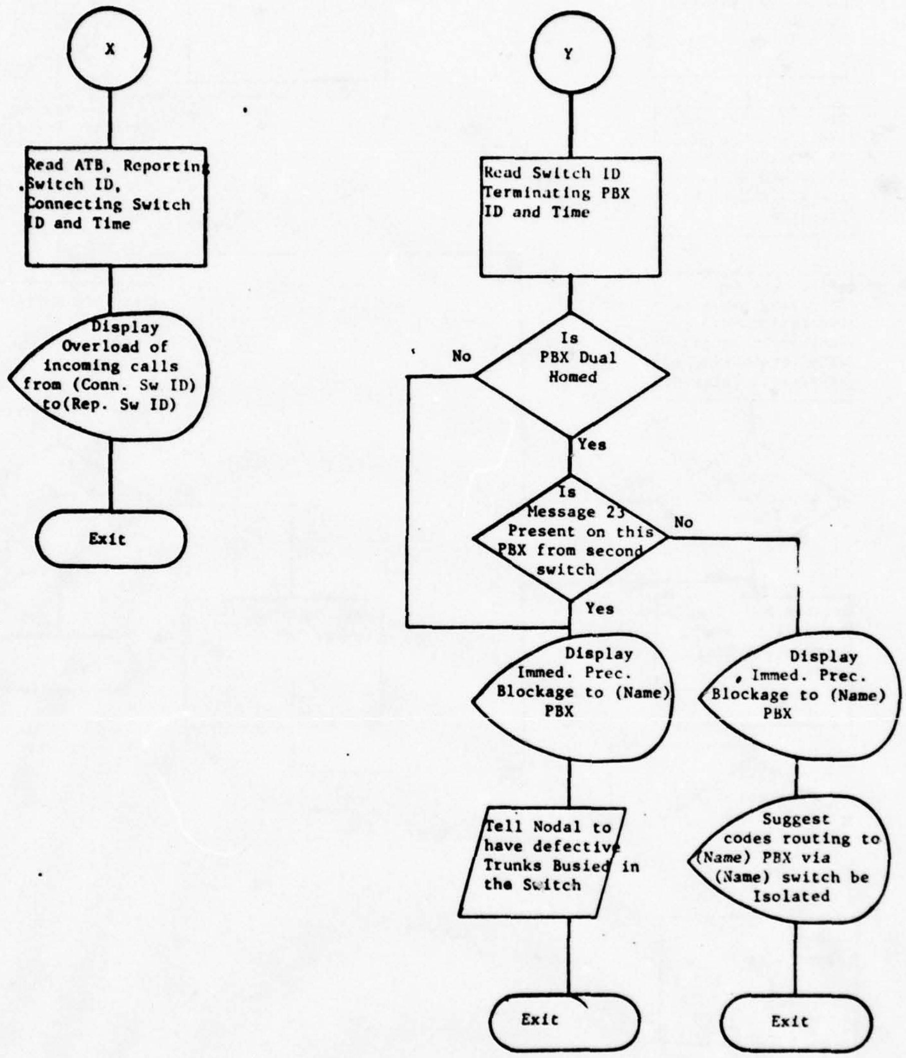
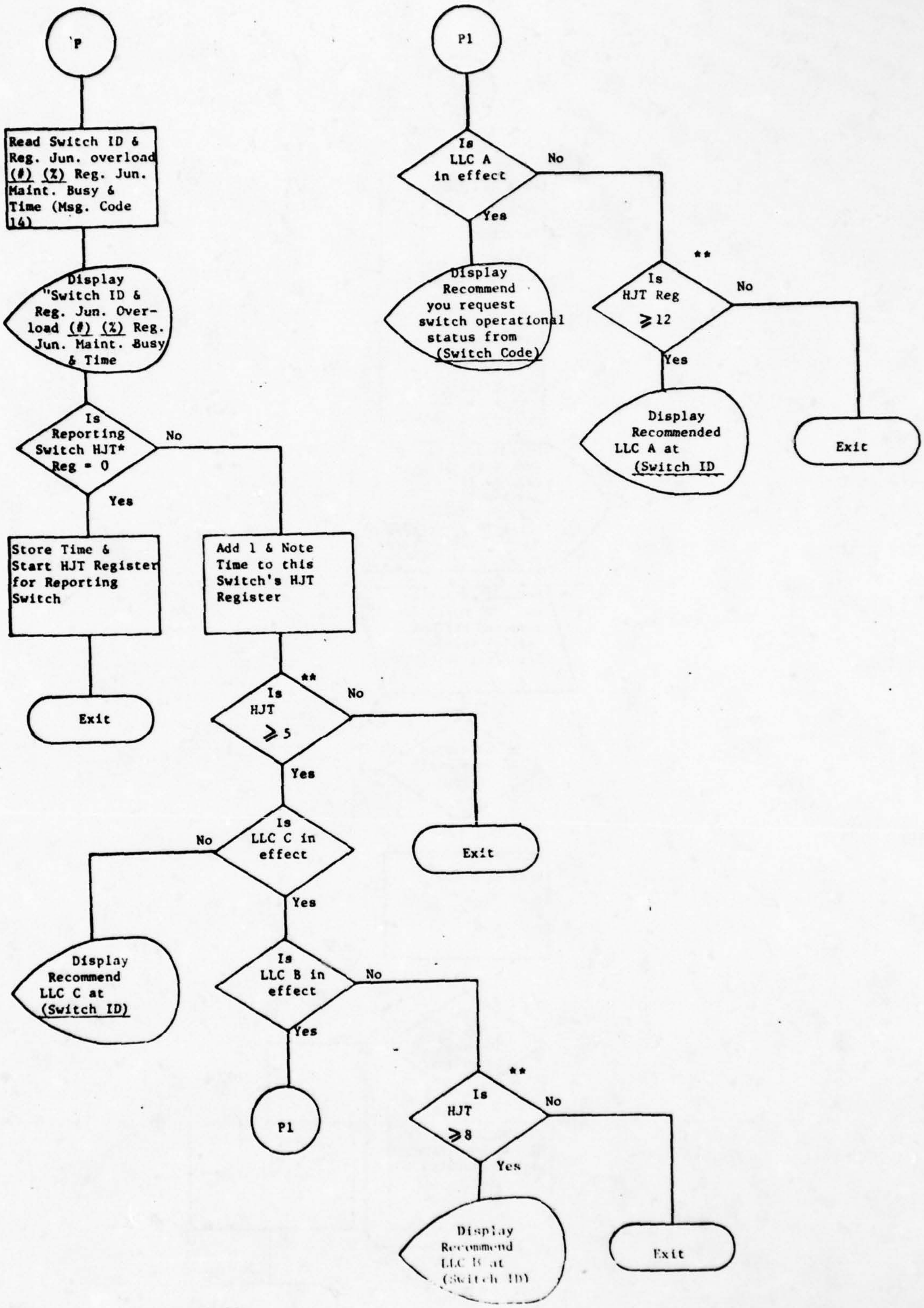


Figure 6.3-3. AUTOVON Traffic Data Correlation Processor (Sheet 9 of 15)



* HJT - Heavy Junctor Traffic
** Variable Threshold - changeable as experience dictates

Figure 6.3-3. AUTOVON Traffic Data Correlation Processor (Sheet 10 of 15)

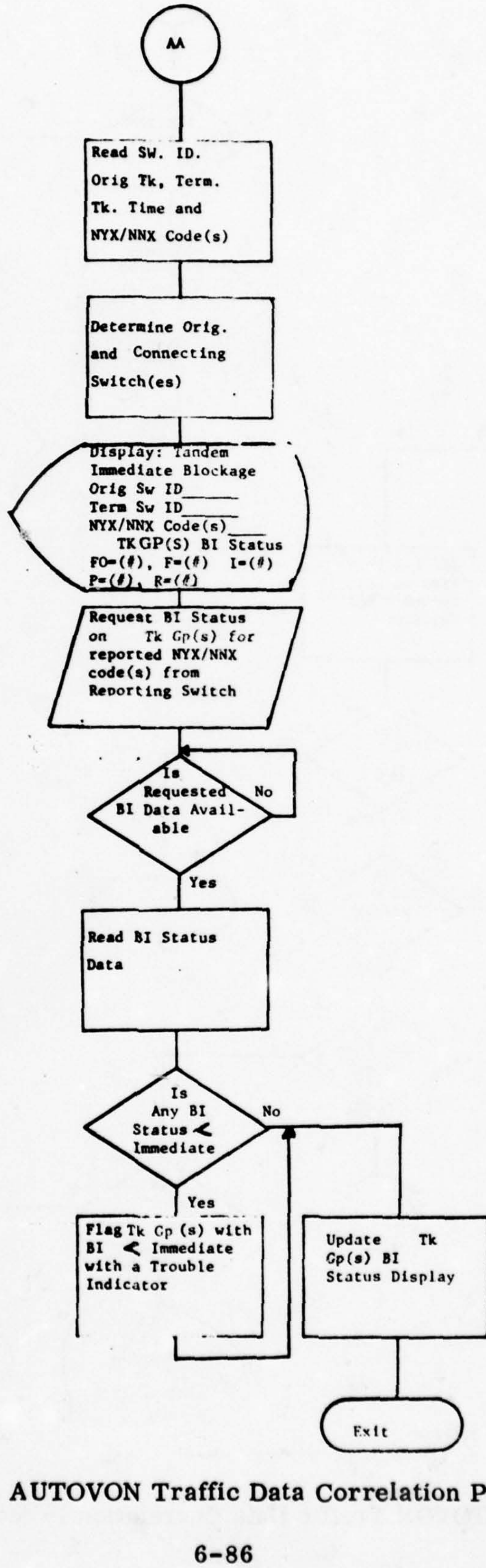


Figure 6.3-3. AUTOVON Traffic Data Correlation Processor (Sheet 11 of 15)

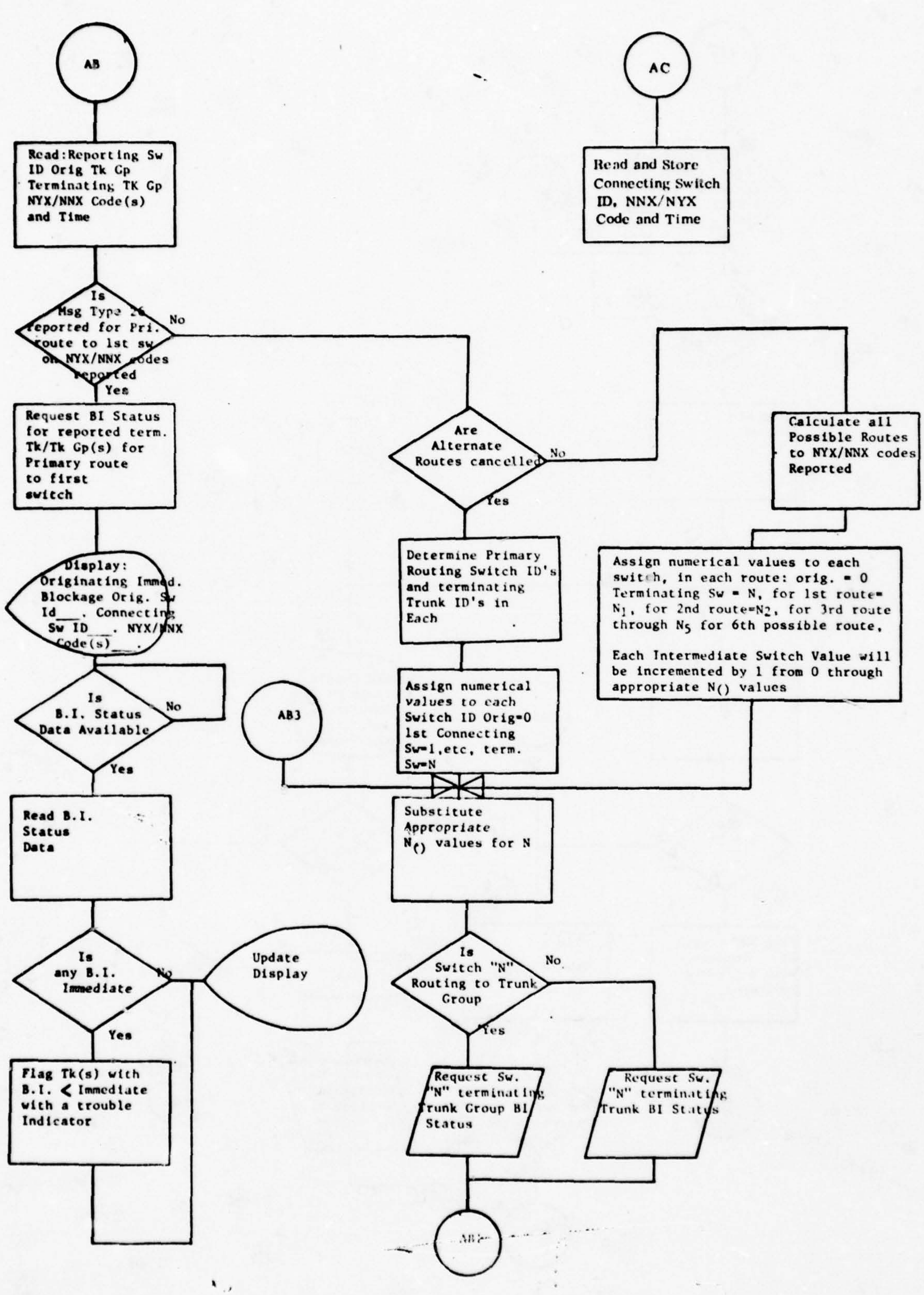


Figure 6.3-3. AUTOVON Traffic Data Correlation Processor (Sheet 12 of 15)

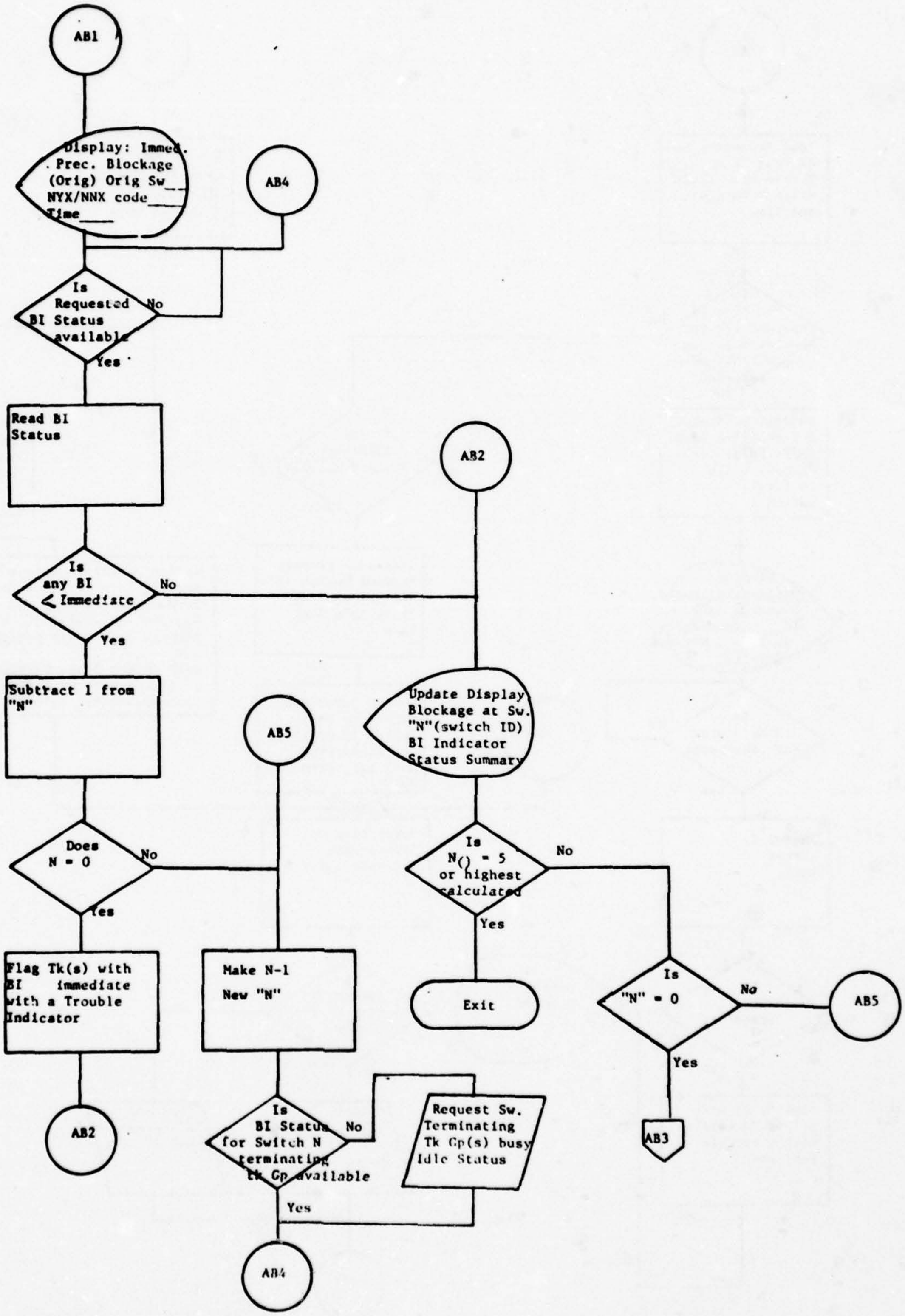


Figure 6.3-3. AUTOVON Traffic Data Correlation Processor (Sheet 13 of 15)

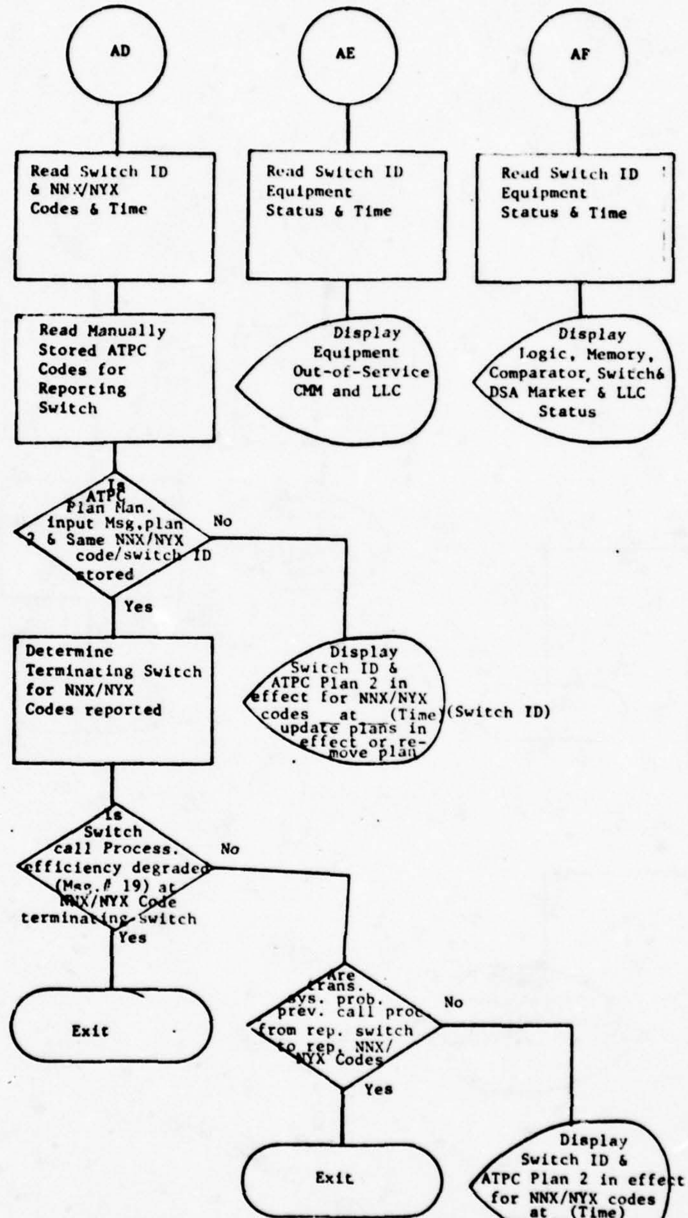


Figure 6.3-3. AUTOVON Traffic Data Correlation Processor (Sheet 14 of 15)

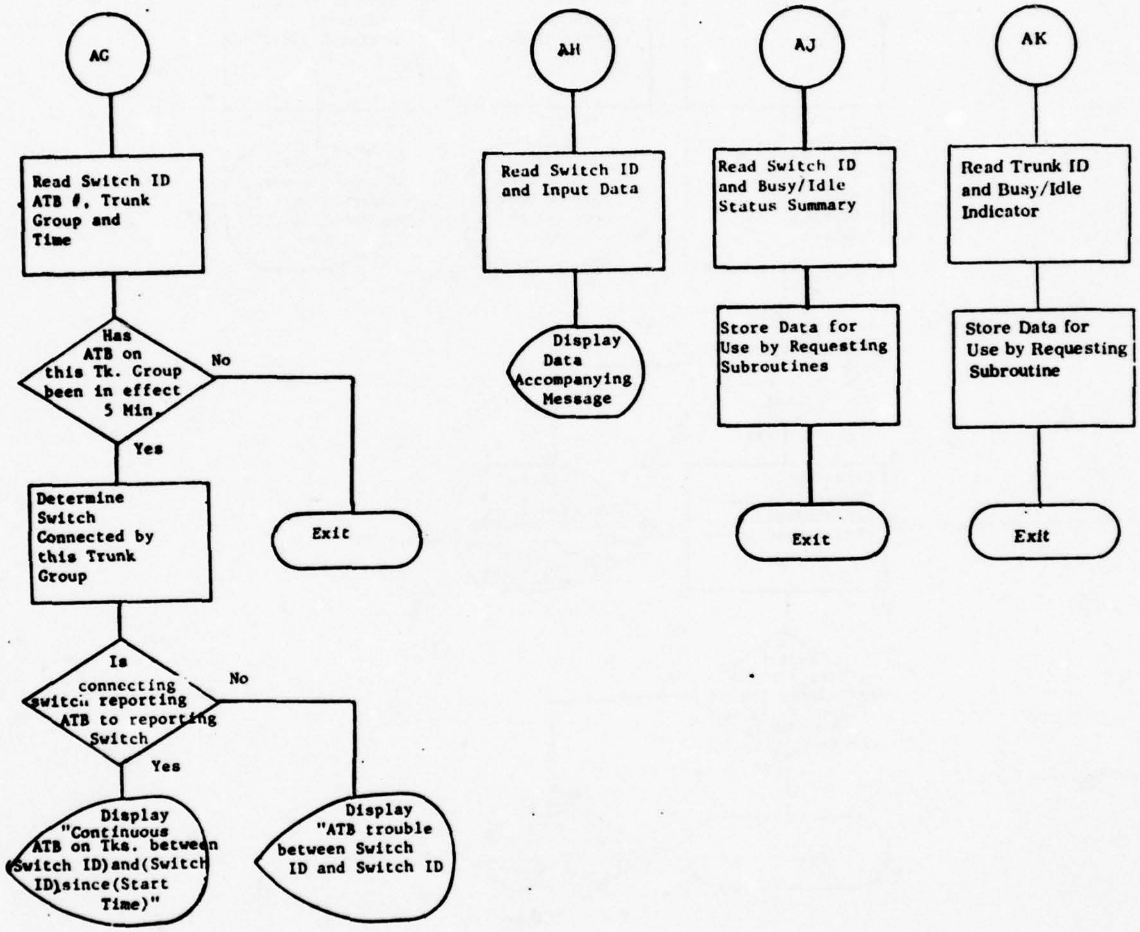


Figure 6.3-3. AUTOVON Traffic Data Correlation Processor (Sheet 15 of 15)

(5) E - Manually Requested Register Junctor Call Processing Efficiency (Sheet 4). In reply to a manual request, the percent of call processing efficiency for any Register Junctor will be supplied for display.

(6) F - TCMF Receiver Overload on Degraded Switch Call Processing Efficiency (Sheet 5). These are extreme overload conditions which are reported only after analysis by the reporting AUTOVON station switch level module. These reports are for immediate display.

(7) G - MF 2/6 Transceiver Overload on Degraded Switch Call Processing Efficiency (Sheet 5). This is processed identically to message Type 6.

(8) H - ATOP and Call Processing Efficiency Invalid (Sheet 5). This is a direct result of the Automatic Overload Protection (ATOP) alarm at the reporting switch.

The "Call Processing Efficiency Percent is Invalid" display is indicated only because ATOP blocks many calls from being presented to the switch.

(9) J - Line Load Control A and Call Processing Efficiency Invalid (Sheet 5). This is a direct result of Line Load Control A in effect at the reporting switch. A decision of whether or not to display the "Call Processing Efficiency Percent Invalid" statement is made based upon the previous presentation of another condition requiring that statement. If one of the other conditions is true, the statement is omitted.

(10) K - Line Load Control B and Call Processing Efficiency Invalid (Sheet 5). This is processed in the same manner as message Type 9 (Line Load Control B).

(11) L - Line Load Control C and Call Processing Efficiency Invalid (Sheet 5). This is processed in the same manner as message types 9 and 10 (Line Load Control A and B).

(12) M - All Registers Busy (Sheet 6). This is a direct report of "All Register Junctors Busy" from the affected switch. The reported data is read and displayed.

(13) N - ATOP Switch Setting Incorrect (Sheet 6). This is a report based upon detection of All Registers Busy and No ATOP signal. Processing is accomplished at the AUTOVON Station Switch Level Module. The reported data is read and displayed.

(14) P - Number and Percent of Register Junctors Maintenance Busy (Sheet 10). This is a report of the number of register junctors maintenance busy when a threshold of Busy Register Junctors is reached.

Upon reading the input data, it is displayed. Then a register of heavy junctor traffic (a summation of message type #14 from the reporting switch) is sampled. If it equals 0, the report is added and the time of the report is noted. If the register total is greater than 0, the total is incremented by one and the time of the latest report is noted. The register is then sampled for an indication of 5 or more reports. If so, and Line Load Control C is in effect, a test is made of Line Load Control B. If Line Load Control C is not in effect, a recommendation for its implementation is displayed. If Line Load Control C is in effect and Line Load Control B is not in effect, the heavy junctor traffic register is again sampled. If its total is equal to or greater than 8, implementation of Line Load Control B is recommended. If both Line Load Controls C and B are in effect, a test of Line Load Control A is made.

If Line Load Controls A, B and C are all in effect, and the heavy junctor traffic register equals 8 or more, a display recommends the ACOC controller request the operational status of the reporting switch. If Line Load Controls B and C are in

effect, and A is not in effect, the heavy junctor traffic register is sampled. If its total is equal to or greater than 12, a display recommending implementation Line Load Control A is presented.

The thresholds for determining the need of Line Load Control implementation are variable and can be changed as experience dictates. A general housekeeping routine will clear the heavy junctor traffic registers when the last report has been stored long enough to indicate the critical condition no longer exists.

(15) Q - Number and percent of TCMF Receivers Maintenance Busy on Threshold TCMF Receivers Busy (Sheet 6). This is an indication of impending heavy DTMF type traffic when some DTMF Receivers are unavailable. Processing involves reading and display of data.

(16) R - Number and Percent of MF 2/6 Transceivers Maintenance Busy on Threshold of MF 2/6 Transceivers Busy (Sheet 6). This is an indication of impending heavy MF 2/6 type traffic when some MF Transceivers are unavailable. Processing involves reading and display of data.

(17) S - Pool Equipment Status in Reply to Manual Request (Sheet 6). This is a direct report of all Register Junctor, TCMF Receiver and MF 2/6 Transceiver Status in reply to a manual request.

(18) T - Assigner Problem on Degraded Call Processing Efficiency (Sheet 7). This report is the result of the reporting switch's call processing efficiency being less than 90 percent and an indication of the inability to assign TCMF Receivers or MF 2/6 Transceivers. Processing is limited to reading input data and displaying it.

(19) U - Degraded Call Processing Efficiency (By Switch) (Sheet 7). This report is the result of the reporting switch's call processing efficiency being less than 90 percent. Processing is limited to reading input data and displaying it.

(20) V - Manually Requested Switch Call Processing Efficiency (Sheet 7). This is a report of a switch's call processing efficiency in reply to a manual request. Processing is limited to reading input data and displaying it. Provisions for displaying previously recently stored call processing efficiency data while waiting for an update are also made (Connector V1).

(21) W - Excessive Number of Calls Being Alternate Routed from Reporting Switch to a Connecting Switch for ______ NNX/NYX Code(s). (Sheet 8). This is a report of a precedence call being blocked from an alternate route because of insufficient precedence level when over 60 percent of the calls are moving in the direction of the terminating switch, and over ___* (Threshold Percent) of these calls not on their primary trunk group. The input data of message type, reporting switch identity, and connecting switch identity are used to determine the Route(s) on which the call was blocked, and the switch in which the blockage occurred. During the processing, Busy/Idle indicator summaries are requested for affected trunk groups in the appropriate switch(es) and are used to determine where blockage occurred. The result of the processing will be a determination if the blockage was genuine, and if so, cancellation of the affected alternate route will be recommended.

* Threshold to be determined.

(22) X - ATB and Receiving an Excessive Number of Calls from Connecting Switch (Sheet 9). This is a report of Precedence Blocked calls incoming on trunks from a particular switch when over 60 percent of trunks from that switch are originating calls into the reporting switch, all trunks on the incoming trunk group are busy, and a precedence call is blocked attempting to find a route out of the reporting switch.

Processing is limited to reading input data and displaying it.

(23) Y - Immediate Preceaence Blockage Terminating to a PBX (Sheet 9). This is a report of Immediate or Higher Precedence being blocked in an attempt to terminate to a PBX. Upon reading the input data, a determination of whether the PBX is dual homed or not is made. If the switch is dual homed, a search for a similar trouble report from the second switch is made. If so, the Immediate Precedence Blockage to (PBX Name) message is displayed, followed by a message to the switch to make defective trunks maintenance busy. If the PBX is dual homed and no similar trouble report is present from the second switch, the message "Immediate Precedence Blockage to ___ (PBX Identity), Suggest Codes routing to ___ (PBX Identity) via ___ (Switch Identity) be isolated.

(24) AA - Immediate Precedence Blockage - Tandem Traffic (Sheet 11). This is a report of Immediate or Higher Precedence being blocked in an attempt to tandem through the reporting switch. This report will originate at switches utilizing spill control (normally gateways). Upon reading the input data, the originating and terminating connecting switches are determined, and available data is displayed. A request for a status update on the normal terminating trunk group is forwarded to the reporting Switch Level Module, and the display is updated upon receipt of the status information. If the trunk group reports any status lower than Immediate precedence, the display is flagged indicating trunk trouble.

(25) AB - Immediate Precedence Blockage - Originating (Sheets 12 and 13). This is a report of Immediate or Higher Precedence blockage of a call originated at the reporting switch.

Upon reading the input data, a test is made to determine if a message type 26 is available from the reporting switch on the switch (trunk group(s)) on which the Reported NNX/NYX codes are primarily routed. If so, the status of the trunks on this route is requested from the reporting switch. The originating Immediate Blocking Message with appropriate data is displayed, and after receipt of the trunk status summary, is updated. If any status was lower than Immediate precedence, the appropriate trunk group display is flagged with a trouble indicator.

If no applicable message type 26 is available, a test is made to determine if alternate routes for the reported NNX/NYX code(s) have been previously cancelled. If they have, the primary routing for the NNX/NYX code(s) reported is determined from the area routing tables, and each switch in the route is tested for blockage, and the Immediate Precedence blockage reporting switch and the switch where blockage is occurring is displayed.

If alternate routes for the reported NNX/NYX code(s) have not been previously cancelled, all possible routes for the NNX/NYX code(s) reported are reconstructed, and the first six are tested for blockage conditions at an intermediate switch. A display is presented showing the Immediate precedence blockage, reporting switch and the switch where blockage is occurring.

(26) AC - Overload in 1st Tandem Switch (Sheet 12). This is a report indicating the first switch in Tandem in unable to route a call, and the originating switch alternate route counter has reached a count of 5 because of the second switch's inability to route the call. Processing is limited to storage of the input data for processing upon receipt of a message type 25 input.

(27) AD - ATPC Plan #2 Announcement Accessed (Sheet 14). This is a report that the isolated code announcement at the reporting switch has been selected as the terminator for a call.

Upon receipt of the data accompanying this message, all ATPC codes stored by the ACOC Controller for the reporting switch are read. A comparison is then made to determine if the ATPC code accessed equates to one stored, thus is legitimate. If the ATPC code access is legitimate, a test is made of general network conditions in the route of the NNX/NYX codes causing the ATPC access. If no degradation is reported, the reporting switch ID is displayed along with a message questioning the need for the ATPC Plan.

If the NNX code for the ATPC Plan accessed does not compare with one stored by the controller, it is assumed to be erroneously stored, and a message indicating the reporting switch, ATPC Plan #2 in effect for _____ NNX/NYX code(s) at _______ Time, and a reminder to update or remove the plan in effect.

(28) AE - Equipment Status on Degraded Call Processing (Sheet 14). This is a report of Equipment Out of Service conditions, comparator in manual mode, and Line Load Control, when the reporting switch's call processing efficiency is less than 90 percent.

Processing is limited to display of input data.

(29) AF - Manually Requested Equipment Status (Sheet 14). This is a reply containing the in or out of service status of all common control and marker equipment.

Processing is limited to display of input data.

(30) AG - ATB (All Trunks Busy) (Sheet 15). This is a report of ATB on any Inter-Swtich or PBX Trunk group. Upon receipt of the input data, a test is made to determine if the condition has existed for 5 minutes or longer. Nothing is done if it has not.

If the condition has persisted for 5 minutes, the connecting switch is determined on Inter-Switch trunk groups, and a test is made to determine if the connecting switch also indicates ATB on the trunk group to the reporting switch. If so, "Continuous ATB on trunks between (Reporting Switch ID) and (Connecting Switch ID) since (Starting Time). If ATB is not true on the connecting switch's trunk group, a display indicating ATB trouble between (switch ID's) is prescribed.

(31) AH - General Data Input (Sheet 15). This is a reply to any manually requested data. Processing is limited to reading and displaying input data.

(32) AJ - Busy/Idle Status Summary (Sheet 15). This is a reply to automatic requests made by other subroutines. Processing is limited to reading and storing data for use by the requesting subroutines.

(33) AK - Busy/Idle Indicator (Sheet 15). This is a reply to automatic requests made by other subroutines. Processing is limited to reading and storing data for use by the requesting subroutines.

6.3.3.2.3 AUTOVON Traffic Display Processor

This algorithm, shown in Figure 6.3-4, processes inputs from the ACOC controller. Sheet 1 illustrates the response to requests for more information. Five types of requests are possible:

1. Request #5 - Register Junctor Call Processing Efficiency
2. Request #17 - Pool Equipment Status
3. Request #20 - Switch Call Processing Efficiency
4. Request #29 - Equipment Status
5. Request #31 - General Data

Sheet 2 shows the routine for storing and displaying the control actions that have been implemented by the controller. A list of codes is included as Table 6.3-11. Upon reading and storage of the manual input action, those codes relating to Line Load Control are separated from the remainder and a display indicating that the

switch action has not been taken is presented until a report indicating the action in effect has been received from the appropriate switch. Regardless of the action data type, a display of manual control actions in effect is presented every five minutes for thirty seconds.

The remove section of this algorithm deletes any manually input action upon demand.

6.3.3.3 Optional Display

A comprehensive near real time display of the switching network situation including traffic overloads, manually input alternate routing decisions, i.e., ATPC Plans, Red Decks, or Directionalization of trunks, could be provided by use of a large situation display board utilizing a geographically oriented communications area layout and alpha-numeric/graphic computer controlled display. The improved system visability provided by this type of display is necessary to supplement the smaller less comprehensive CRT display. The benefits derived from the improved system visability make its inclusion at the ACOC worth consideration. Figures 6.3-5 and 6.3-6 depict a concept of this type of display for Europe.

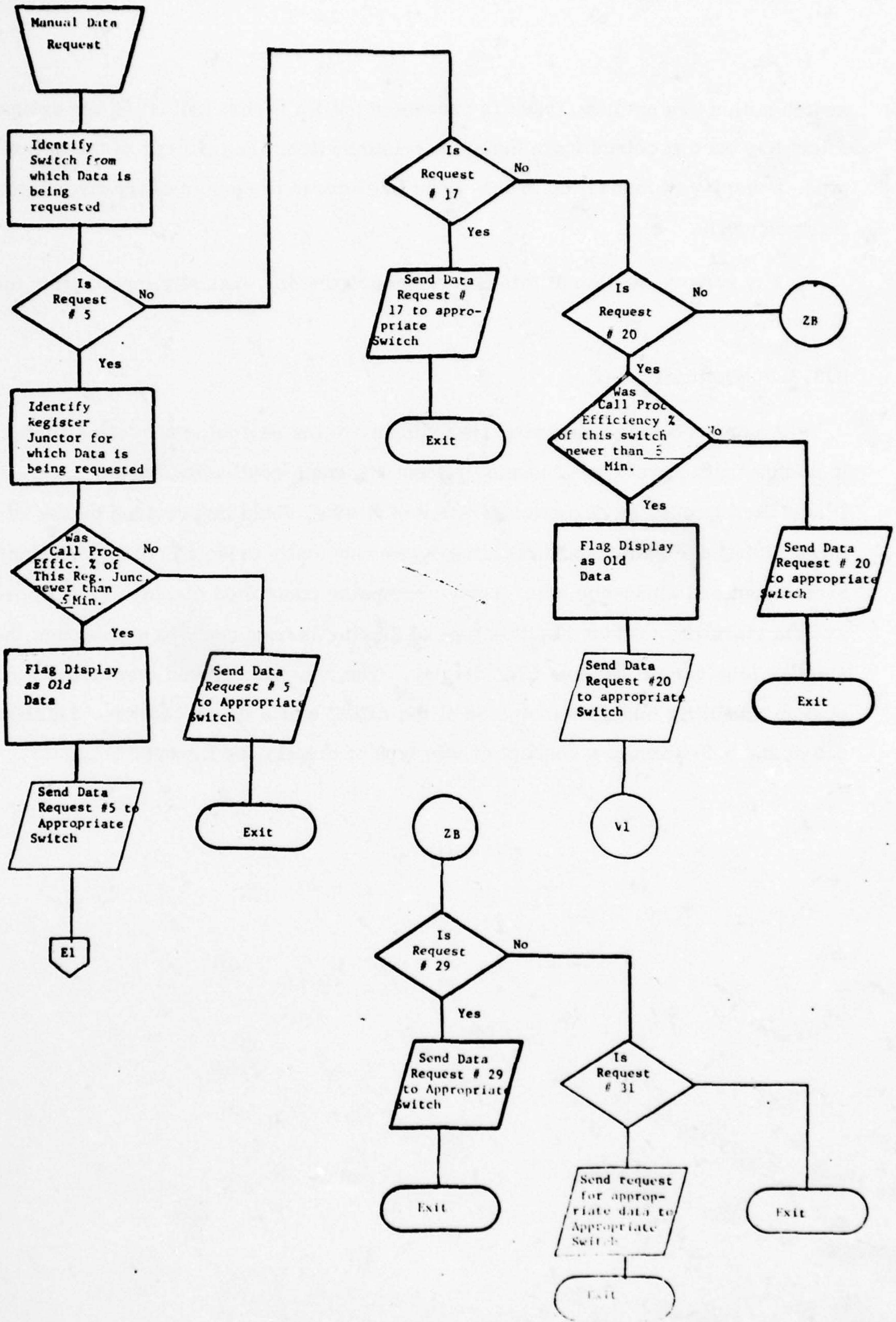


Figure 6.3-4. AUTOVON Traffic Display Processor (Sheet 1 of 2)

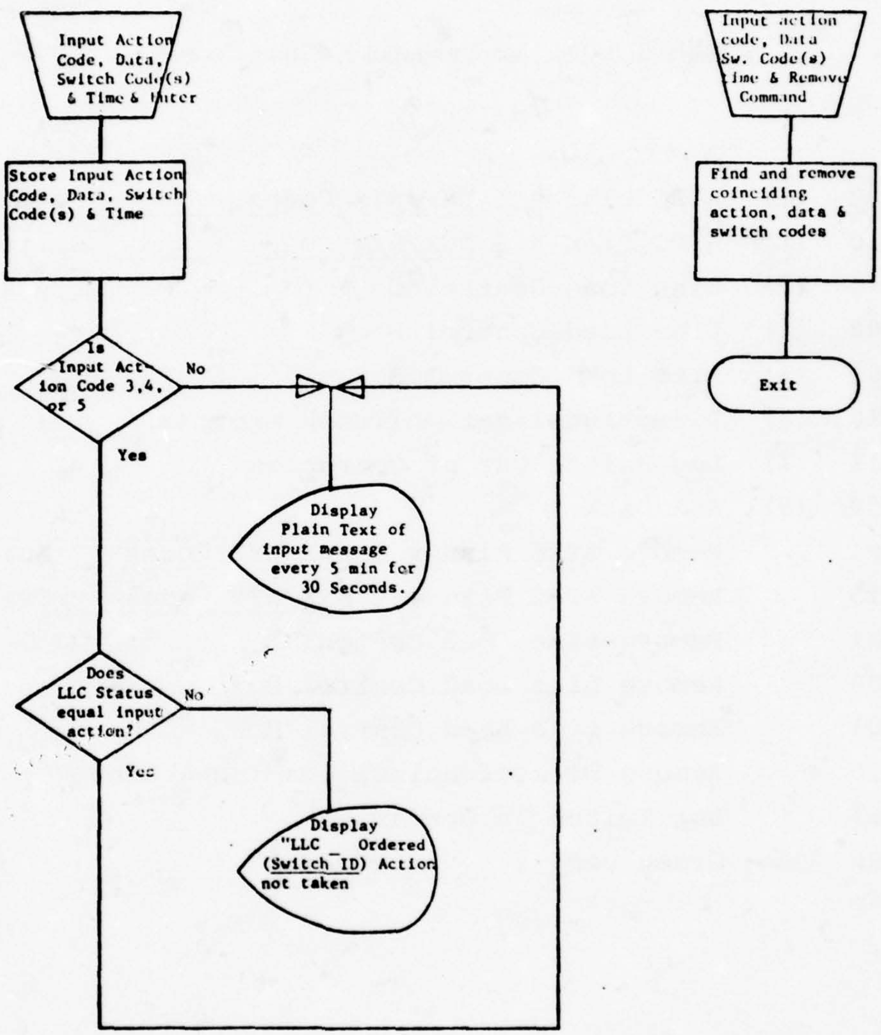


Figure 6.3-4. AUTOVON Traffic Display Processor (Sheet 2 of 2)

Table 6.3-11. Manual Input Actions Codes

00000001	(1)	ATPC Plan # 1 NNX/NYX Codes _______Switch Code(s)
00000010	(2)	ATPC Plan # 2 NNX/NYX Codes _______Switch Code(s)
00000011	(3)	Line Load Control C
00000100	(4)	Line Load Control B
00000101	(5)	Line Load Control A
00000110	(6)	Directionalization(Trunk Group(s)_____)
00000111	(7)	Log Switch Out of Operation
00001000	(8)	Red Deck # ____
00010001		Remove ATPC Plan # 1 NNX/NYX Codes ___Switch Code(s)
00010010		Remove ATPC Plan # 2 NNX/NYX Codes ___Switch Code(s)
00010011		Remove Line Load Control C
00010100		Remove Line Load Control B
00010101		Remove Line Load Control A
00010110		Remove Directionalization(Trunk Group(s)____)
00010111		Log Switch In Operation
00011000		Green Deck # ___

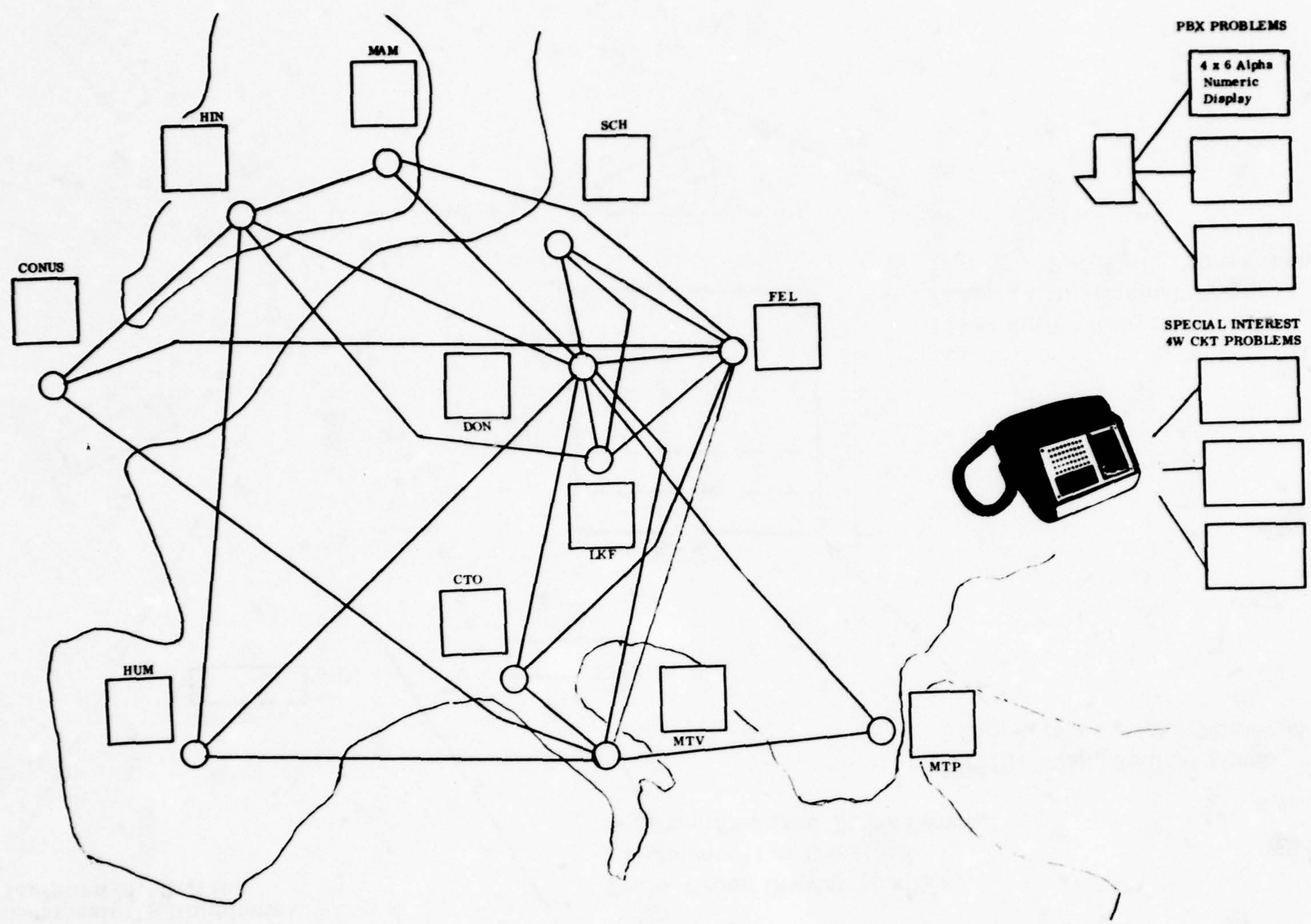


Figure 6.3-5. ACOC AUTOVON Situation Display

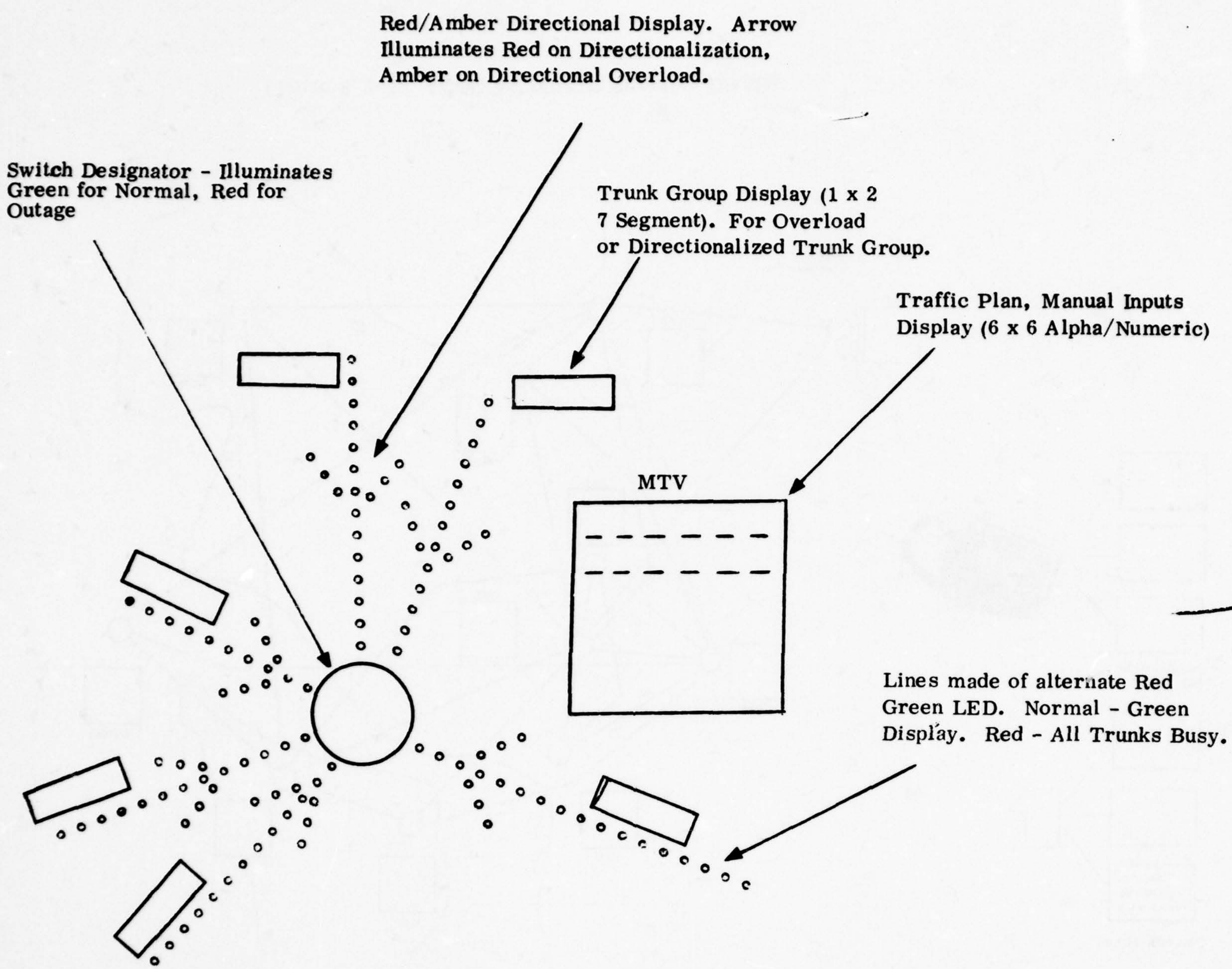


Figure 6.3-6 . Enlarged Segment of ACOC AUTOVON Situation Display
(Approximately 50% of Full Size)

SECTION 7 - COSTING

7.1 GENERAL

Budgeting costing for the unified control system is presented in this section. Hardware, special interface, engineering, software, and documentation costs are addressed specifically for the European DCS.

7.2 HARDWARE COSTS FOR UNIFIED CONTROL

The hardware costs presented in this paragraph include the costs of significant off-the-shelf equipment items and the specially built AUTOVON switch interface. The computer hardware prices are provided for currently available off-the-shelf hardware which satisfies the minimum requirements set forth in earlier sections of this report. Tables 7.2-1 through 7.2-3 summarize hardware costs for single installations of the ACOC, Sector, and Node level elements respectively. Table 7.2-4 presents station level hardware costs including terminal and switch interface equipment for the entire European DCS. Table 7.2-5 shows the estimated hardware costs for Europe assuming that the unified control systems consists of one ACOC, four Sector, and sixteen Node installations.

From this table, the European hardware cost is on the order of $1.6M. This cost assumes that communications facilities providing interfaces among the various unified control elements are supplied out of the current DCS.

7.3 SOFTWARE COSTS FOR UNIFIED CONTROL

The software implementation and documentation costs for unified control are presented in this paragraph. These costs are derived from the results of the sizing analysis presented in earlier sections of this report, and estimations of software documentation requirements to satisfy military documentation standards.

Table 7.3-1 summarizes the overall software estimates for unified control. The table lists each unique program in the system, the estimated size of the program in lines of code, and shows the major unified control elements where it

Table 7.2-1. Budgetary Hardware Pricing for the ACOC

Equipment	Quantity	Unit Cost	Extended Cost
CPU with 128K bytes	1	20,000	20,000
10M byte moving head disk and controller	1	12,000	12,000
Magnetic Tape Drive and Controller	1	10,000	10,000
CRT Terminal with Local Print and Controller	4	5,000	20,000
Synchronous Channel	6	1,200	7,200
Total			$69,200

Table 7.2-2. Budgetary Hardware Pricing for the Sector

Equipment	Quantity	Unit Cost	Extended Cost
CPU with 128K bytes	1	20,000	20,000
10M byte moving Head Disk and Controller	1	12,000	12,000
Magnetic Tape Drive and Controller	1	10,000	10,000
CRT Terminal with Local Print and Controller	2	5,000	10,000
Synchronous Channel	8	1,200	9,600
Total			$61,600

Table 7.2-3. Budgetary Processor/Peripheral Hardware Pricing for the Node

Equipment	Quantity	Unit Cost	Extended Cost
CPU with 128K bytes	1	20,000	20,000
5M byte Moving Head Disk	1	10,000	10,000
Magnetic Tape Drive and Controller	1	10,000	10,000
Node Controller CRT Terminal with Local Print	1	5,000	5,000
Synchronous Channel (ACOC + ATEC)	2*	1,200	2,400
Total			47,400

*Assume each Node interface with ATEC

Table 7.2-4. Budgetary Station Level Hardware Pricing

Equipment	Quantity	Unit Cost	Extended Cost
Station Controller CRT Terminals	57[1]	3,000	171,000
Station Controller CRT Terminals with Local Print	44[1]	5,000	220,000
AUTODIN Report Processor Interface	3	500	1,500
AUTOVON Switch Interface	10	14,200[2]	142,000
TOTAL			534,500

[1] Requirement for local print capabilities based on the number of circuits in a particular station

[2] Trunk Scanner Interface Buffer - 4500
Level Converter and Multiplexer - 6600
Racks, cables, PCB files - 2500
Multiplexer Dual Power Supply - 600
Total 14,200

Table 7.2-5. Summary of Unified Control Hardware Pricing for Europe.

Functional Level	Cost/ Installation	Number of Installations In Europe	Extended Cost
ACOC	69,200	1	69,200
SECTOR	61,600	4	246,400
NODE	47,400	16	758,400
STATION	-	-	534,500
TOTAL			$1,608,500

Table 7.3-1. <u>Summary of Overall Unified Control Software Estimates</u>

(Sheet 1 of 5)

PROGRAM NAME	# INST HOL	ACOC	SECTOR	NODE
ACOC Supervisor	300	X		
Sector Supervisor	300		X	
Node Supervisor	300			X
Sector I/O Driver	100	X	X	X
ACOC I/O Driver	100	X	X	
Node I/O Driver	100		X	
CRT I/O Driver	200	X	X	X
STATS I/O Driver	75	X		
ATEC I/O Driver	100			X
VON Module I/O Driver	100			X
AUTODIN I/O Driver	100			X
ACOC Message Processor	50	X		
ACOC Message Processor (S)	50		X	
Sector Message Processor	50	X		
Sector Message Processor (S)	50		X	
Sector Message Processor (N)	50			X
Node Message Processor	50		X	
ACOC Controller Message Processor	50	X		
Sector Controller Message Processor	50		X	
Nodal Controller Message Processor	50			X
Station Message Processor	50			X
STATS Message Processor	50	X		
SATCOM Message Processor	50	X		
ATEC Message Processor	50			X
AUTOVON Message Processor	50			X
AUTODIN Message Processor	50			X
Journal Inspection Processor	275	X	X	
Journal Inspection Processor (N)	75			X
Fault Notification Broadcast Processor	250	X		
Fault Notification Broadcast Processor (S)	300		X	
Fault Notification Broadcast Processor (N)	275			X
Fault Update Broadcast Processor	250	X		
Fault Update Broadcast Processor (S)	300		X	
Fault Update Broadcast Processor (N)	275			X
Fault Closure Broadcast Processor	250	X		
Fault Closure Broadcast Processor (S)	300		X	
Fault Closure Broadcast Processor (N)	275			X
Broadcast Message Generator	100	X	X	X
Fault Summary Processor	150	X	X	
Node Fault Summary Processor	200			X

Table 7.3-1. Summary of Overall Unified Control Software Estimates

(Sheet 2 of 5)

PROGRAM NAME	# INST HOL	ACOC	SECTOR	NODE
Fault Record Retrieve	50	X	X	
Fault Record Retrieve (N)	100			X
ACOC Fault Retrieval Processor	75	X		
ACOC Fault Destination Processor	50	X		
Sector Fault Retrieval Processor	75		X	
Sector Fault Destination Processor	50		X	
Sector Fault Update	100		X	
Sector Traffic Fault Processor	75		X	
Node Fault Retrieval Processor	75			X
Node Fault Destination Processor	75			X
Node Fault Input Processor	400			X
Node Fault Update	150			X
Fault Responsibility Accept	75			X
Station Fault Accept	100			X
Station Fault Update	150			X
Station Fault Close	200			X
Connectivity Display Processor	200	X	X	
Connectivity Display Processor (N)	200			X
Connectivity Modification Processor	500	X	X	X
Connectivity Mod Request Processor (S)	50		X	
Network Modification Processor	75	X		
Configuration Update Processor	50			X
Reroute Directive Processor	100	X	X	
Reroute Authorization Processor	50	X		
Reroute Confirmation Processor	200	X		
Reroute Confirmation Processor (S)	200		X	
Reroute Confirmation Processor (N)	200			X
Reroute Request Processor	50		X	
Node Reroute Destination Processor	50			X
Media Status Retrieval Processor	250	X	X	X
PMP/QA Measurement Processor	50	X		
Sector PMP/QA Measurement Processor	50		X	
PMP/QA Request Processor	50		X	X
PMP/QA Gather	50		X	
PMP/QA Data Accept	75			X
PMP/QA Destination Processor	50			X
Measurement Destination Processor	50		X	
Manual Measurement Request Proc (S)	50		X	
Manual Measurement Request Proc (N)	50			X
Manual Measurement Accept	75			X

Table 7.3-1. Summary of Overall Unified Control Software Estimates

(Sheet 3 of 5)

PROGRAM NAME	# INST HOL	ACOC	SECTOR	NODE
Manual Measurement Destination Proc (N)	50			X
Sector Manual Measurement Processor	75		X	
Automated Measurement Request Proc (S)	50		X	
Sector Automated Measurement Proc	75		X	
Free Text Message Processor	50	X	X	X
SATCOM Fault Accept	75	X		
SATCOM Fault Update	100	X		
SATCOM Fault Close	100	X		
Traffic Control Processor	100	X		
STATS Summary Processor	50	X		
AUTOVON Traffic Processor	300	X		
AUTOVON Station Equipment Processor	50	X		
AUTODIN Station Equipment Processor	50	X		
AUTOSEVOCOM Station Equip Processor	50	X		
HAZCON Processor	75		X	
HAZCON Accept	100			X
Station Initialize	50			X
Link Connectivity Retrieve	50	X	X	X
VFCT Trunk Connectivity Retrieve	200	X	X	X
Trunk Connectivity Retrieve	100	X	X	X
CCSD Connectivity Retrieve	200	X	X	X
Link Connectivity Update	100	X	X	X
VFCT Trunk Connectivity Update	400	X	X	X
Trunk Connectivity Update	200	X	X	X
CCSD Connectivity Update	400	X	X	X
Station Equipment Update	100	X	X	X
Switch Equipment Update	100	X		
Precedence Determine	400	X		
Precedence Determine (S)	400		X	
Precedence Processor	400			X
Destination Processor	50	X	X	X
Terminating Sector Determine	50	X	X	
Destination Sector Determine	150	X	X	
Terminating Node Determine	50		X	X
Destination Node Determine	150		X	X
Terminating Station Determine	50			X
Destination Station Determine	150			X
Fault File Manager	150	X	X	X
Fault Summary Generator	50	X	X	X
Associated Fault Purge	100		X	X

Table 7.3-1. Summary of Overall Unified Control Software Estimates

(Sheet 4 of 5)

PROGRAM NAME	# INST HOL	ACOC	SECTOR	NODE
Detailed Fault Generator	75			X
Control Action Log Manager	150	X		
Journal Output Manager	50	X	X	X
Connectivity Mod Syntex Check	100	X		
CRT Output Buffer Manager	200	X		
CRT Output Buffer Manager (S)	100		X	X
DIN Traffic Threshold Check	50	X		
VON Traffic Data Correlation Processor	750	X		
AUTOVON Traffic Display Processor	300	X		
AUTODIN Traffic Display Processor	50	X		
AUTOVON Switch Equip Status Retrieve	50	X		
AUTODIN Switch Equip Status Retrieve	50	X		
AUTOSEVOCOM Switch Equip Status Retrieve	50	X		
ATEC Query Processor	150			X
AUTODIN Station Initialize	50			X
AUTOVON Station Initialize	50			X
AUTOSEVOCOM Station Initialize	50			X
TCF Station Initialize	50			X
Earth Terminal Complex Station Initialize	50			X
Station File Manager	175	X	X	X
Link File Manager	175	X	X	X
Trunk File Manager	150	X	X	X
VFCT Trunk Manager	175	X	X	X
CCSD File Manager	200	X	X	X
Journal Input Manager	175	X	X	X
Journal Display Formatter	100	X	X	X
Communications Message Formatter	150	X	X	X
Display File Manager	50	X	X	X
Display Generator	50	X		
Display Generator (S)	50		X	
Display Generator (N)	50			X
Fault File Search	75	X	X	X
Fault File Linkage Modification	150	X	X	X
Fault Filter	50	X	X	X
Related Fault Record Manager	50	X	X	X
AUTOVON Detail File Manager	100	X		
AUTODIN Detail File Manager	100	X		
AUTOSEVOCOM Detail File Manager	100	X		
Precedence Determine (N)	100			X

Table 7.3-1. Summary of Overall Unified Control Software Estimates
(Sheet 5 of 5)

PROGRAM NAME	# INST HOL	ACOC	SECTOR	NODE
ATEC Message Generator	50			X
ATEC Fault Record Generator	75			X
VON Fault Record Generator	75			X
DIN Fault Record Generator	75			X
AUTOVON Trunk Translator	50			X
ACOC Controller Decode/Validation	100	X		
SATCOM Controller Decode/Validation	75	X		
Sector Controller Decode/Validation	100		X	
Node Controller Decode/Validation	75			X
Station Operator Decode/Validation	100			X
Message Type Decode	175	X	X	X
AUTOVON Message Decode	50			X
AUTODIN Message Decode	50			X
I/O Error Processor	150	X	X	X
Journal Block Formatter	150	X	X	X
Communications Buffer Manager	100	X	X	X
CRT Buffer Manager	75	X	X	X
STATS Buffer Manager	50	X		
Station Output Buffer Manager	200			X
AUTODIN Buffer Manager	100			X
AUTOVON Buffer Manager	100			X
ATEC Buffer Manager	100			X
Communications Message File Manager	50	X	X	X
FIND	500	X	X	X
GET	500	X	X	X
CREATE	500	X	X	X
DELETE	500	X	X	X
MODIFY	500	X	X	X
VON Module	1625			
TOTAL	26,625			

is used. This table only addresses installed code which is estimated to consist of 26,625 unique lines.

Table 7.3-2 presents the software labor estimates for the system. The table includes labor estimates for design, coding, and debugging of the software, requirements and product specifications, test plans, and user's manuals. The design, code, and debug estimate is based on 26,625 line of operational software and 3,000 lines of auxiliary data base preparation software. The estimated labor for software activities is 4803 man days or about 20.5 man years.

Table 7.3-2. Bugetary Software Development and Documentation Cost Estimates for Unified Control

TASK	NO. MAN DAYS	RATIONALE
Design, Code, Debug	3703	29,625* lines at 8 lines/day
Requirements Specific-ations (B5)	250	500 pages at 2 pages/day
Product Specifications (C5)	450	900 pages at 2 pages/day
Test Plans	250	500 pages at 2 pages/day
User's Manuals	150	300 pages at 2 pages/day
TOTAL	4803	

* Installed Software - 26,625 lines
6 Major File Generators - 3,000 lines
@ 500 lines each

TOTAL - 29,625 lines

APPENDIX A

This Appendix contains the detailed descriptions of the algorithms used in the loading analysis. Each algorithm is flowcharted and analyzed for the number of assembly level instructions executed, disk accesses performed, and characters displayed in performing a single execution of the algorithm.

ALGORITHM - A1

DESCRIPTION - ACOC - Receipt of Fault Notification Broadcast from Sectors

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Input Handling	145	1	--	30 byte message @ 2 inst/byte for error processing. 25 instructions/buffer switch 10 inst to decode message 1 disk access for overlay @ 50 inst/access
Message Parsing	100	--	--	25 data bytes @ 4 inst/byte
Severity Check	25	--	--	5 severities @ 5 inst/check
Media Record Retrieval	230	2	--	2 disk accesses - 1 directory; 1 record 50 inst/access - 100 inst 5 directories @ 10 inst/dir address compute Hash - 8 character field @ 10/char
Fault ID Update	30	--	--	3 words @ 10 inst/word
Reroute Flag Update	10	--	--	1 word @ 10 inst/word

ALGORITHM - A1 (Continued)

DESCRIPTION - ACOC - Receipt of Fault Notification Broadcast

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Isolation Indicator Update	10	--	--	1 word @ 10 inst
DoD Update	10	--	--	1 word @ 10 inst
Restore Media Record	60	1	--	10 inst for linkage 50 inst for disk access
ACOC Notification Check	50	--	--	2 theaters @ 25 inst/check
ACOC Notification Message Forwarding	140	--	--	2 ACOC (10 inst to affix destination 10 inst to affix source 50 inst to move
Controller Status Summary Update	120	--	--	12 fields @ 10 inst/field

ALGORITHM - A1 (Continued)

DESCRIPTION - ACOC - Receipt of Fault Notification Broadcast

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Notification Output	75	--	5	5 char @ 15 inst
TERM	1005	4	5	

ALGORITHM - A2

DESCRIPTION - ACOC - Fault Notification from Another ACOC

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Input Handling	145	1	--	30 byte message @ 2 inst/byte for error processing 25 instructions/buffer switch 10 inst to decode message 1 disk access for overlay @ 50 inst/access
Message Parsing	100	--	--	25 data bytes @ 4 inst/byte
Severity Check	25	--	--	5 severities @ 5 inst
Media Record Retrieval	230	2	--	2 disk accesses - 1 directory; 1 record @ 50 inst/access 5 directories @ 10 inst for address computation 8 character field @ 10 inst/char for Hash
Fault ID Update	30	--	--	3 words @ 10 inst
Reroute Flag Update	10	--	--	1 word @ 10 inst

ALGORITHM - A2 (Continued)

DESCRIPTION - ACOC - Fault Notification from Another ACOC

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Isolation Indicator Update	10	--	--	1 word @ 10 inst
DOD Update	10	--	--	1 word @ 10 inst
Restore Media Record	60	1	--	10 inst for linkage 50 inst/disk access
Sector Notification Check	1350	12	--	6 data base accesses @ 2 disk accesses each @ 50 inst 5 trunks/CCSD @ 50 inst 6 stations/trunk @ 50 inst 4 sectors @ 50 inst for destination check
Notification Message Forwarding	280	--	--	4 sectors (10 inst to affix destination 10 inst to affix source 50 inst to move)
Controller Status Summary Update	120	--	--	12 fields @ 10 inst

ALGORITHM - A2 (Continued)

DESCRIPTION - ACOC - Fault Notification from Another ACOC

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Notification Output	75	--	5	5 characters @ 15 inst
TERM	2475	16	5	

ALGORITHM - A3

DESCRIPTION - ACOC - Switch Summary Message from DIN STATS

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Message Type Decode	75	1	--	1 disk access for overlay @ 50 inst 25 inst for message decode
Parsing	500	--	--	100 values @ 5 inst
Thresholding	600	--	--	2 words/value; 1 cond test/word; 3 inst/test; for 100 values
Journal Prep	500	--	--	10 journal blocks @ 50 inst/block
Journal Output	100	1	--	50 inst for journal management; 50 inst for access
Traffic File Update	100	1	--	1 access to write summary @ 50 inst 50 inst to select traffic file

ALGORITHM - A3 (Continued)

DESCRIPTION - ACOC - Switch Summary Message from DIN STATS

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Controller Status Summary Update	250	--	--	25 characters @ 10 inst/char
Display Update	375	--	25	25 characters @ 15 inst/char
TERM	2500	3	25	

ALGORITHM - A4

DESCRIPTION - ACOC - Request to Enter a Fault Report (SATCOM)

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Input Handling	750	1	--	45 character Message @ 15 inst/char for validation 25 inst/buffer switch 1 disk access for overlay @ 50 inst
Parsing	80	--	--	8 fields @ 10 inst
Generate Fault Record	200	--	--	20 fields @ 10 inst
Media Type Check	100	--	--	4 levels @ 25 inst
Media Record Retrieval	230	2	--	1 media file access @ 2 disk accesses @ 50 inst 8 character field @ 10 inst/char for hash 50 inst for directory arbitration
Status Check Not Previously Reported	28	--	--	25 inst to determine status 3 inst for conditional test

ALGORITHM - A4 (Continued)

DESCRIPTION - ACOC - Request to Enter a Fault Report (SATCOM)

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Retrieve a Fault Record (5 times 1/)	1000	10	--	1 fault file access @ 2 disk accesses - 100 inst 50 inst for pointer processing 50 inst for directory arbitration (for 5 faults)
Precedence/ Severity Comparison	150	--	--	10 conditional tests @ 3 inst each (for 5 faults)
New Fault Higher: Add New Fault to File	672	2	--	5 pointers to adjust @ 10 inst each 174 bytes to move @ 3 inst/byte Write record into fault file @ 2 disk accesses - 100 inst

ALGORITHM - A4 (Continued)

DESCRIPTION - ACOC - Request to Enter a Fault Report (SATCOM)

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Retrieve Next Fault Record	750	10	--	1 fault file access @ 2 disk accesses - 100 inst 50 inst for pointer processing (for 5 faults)
Generate Discontinue Notification	350	--	--	10 inst to retrieve form 4 fields to insert @ 15 inst each (for 5 faults)
5 times				
Notification Output Prep	625	--	125	25 character line @ 5 inst each (for 5 faults)
More Faults? (Yes / No)	5	--	--	Test pointer for end-of-list (for 5 faults)

ALGORITHM - A4 (Continued)

DESCRIPTION - ACOC - Request to Enter a Fault Report (SATCOM)

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Media Record Update / Fault ID Update	30	--	--	3 words @ 10 inst/word
Reroute Flag Update	10	--	--	1 word @ 10 inst
Isolation Indication Update	10	--	--	1 word @ 10 inst
DoD Update	10	--	--	1 word @ 10 inst
Restore Media Record	60	1	--	10 inst for linkage 50 inst for disk
ACOC Notification Check	50	--	--	2 theaters @ 25 inst

ALGORITHM - **A4 (Continued)**

DESCRIPTION - **ACOC - Request to Enter a Fault Report (SATCOM)**

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
ACOC Notification Message Forwarding	140	--	--	2 ACOCs { 10 inst to affix destination; 10 inst to affix source; 50 inst to move
ACOC Controller Status Summary Update	120	--	--	12 fields @ 10 inst
Notification Output	75	--	5	5 char @ 15 inst
TERM	5445	26	130	

1/ Assume 10 faults outstanding; half of higher precedence than the reported fault

ALGORITHM - A5

DESCRIPTION - Retrieve and Display CCSD Connectivity to ACOC Controller

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Input Handling	300	1	--	15 character line @ 15 inst per character 25 inst/buffer switch 1 disk access for overlay @ 50 inst
Request Parsing	70	--	--	15 characters @ 4 inst 10 inst to decode request
Connectivity Overlay Retrieval	60	1	--	10 inst for linkage 50 inst for disk access
Retrieval Type Check	100	--	--	4 levels @ 25 inst
Retrieve CCSD Record	230	2	--	1 CCSD File Access @ 2 disk accesses 8 character field @ 10 inst/char for hash 50 inst for directory arbitration
A				
Extract Trunk and Channel ID	192	--	--	8 bytes @ 4 inst 2/

ALGORITHM - A5 (Continued)

DESCRIPTION - Retrieve and Display CCSD Connectivity to ACOC Controller

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Retrieve Trunk Record	1260	12	--	(1 Trunk File Access @ 2 disk accesses 6 character field @ 10 inst for hash 50 inst for directory arb) 2/
Determine Trunk Direction	150	--	--	25 inst for previous station check 2/
(B)				
Extract Station, Link G/SG	1800	--	--	15 bytes @ 4 inst 1/
Append Channel #	300	--	--	2 characters @ 5 inst 1/
Format Display Buffer	4500	--	--	15 character data line @ 10 inst/character 1/

ALGORITHM - A5 (Continued)

DESCRIPTION - Retrieve and Display CCSD Connectivity to ACOC Controller

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
More Stations? (Y: B; N)	150	--	--	Conditional test and branch 1/
More Trunks? (Y: A; N)	150	--	--	Conditional Test and branch 1/
Dump Display Buffer	6750	--	450	30 lines @ 15 char/line 450 characters @ 15 inst/character
	18,012	16	450	
TERM				

1/ Perform for 6 Trunks each through 5 stations

2/ Perform for 6 Trunks

ALGORITHM - S1

DESCRIPTION - Sector - Receipt of Fault Notification Broadcast from Sectors

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Input Handling	145	1	--	30 byte msg @ 2 inst/byte for error processing 25 inst/buffer switch 10 inst to decode msg 1 disk access for overlay @ 50 inst
Message Parsing	100	--	--	25 data bytes @ 4 inst/byte
Severity Check	25	--	--	5 severity @ 5 inst/check
Media Record Retrieval	230	2	--	2 disk accesses - 1 directory; 1 record @ 50 inst/access 5 directories @ 10 inst/dir address compute 8 character field @ 10 inst/char
Fault ID Update	30	--	--	3 words @ 10 inst/word
Reroute Flag Update	10	--	--	1 word @ 10 inst/word

ALGORITHM - S1 (Continued)

DESCRIPTION - Sector - Receipt of Fault Notification Broadcast from Sectors

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Isolation Indicator Update	10	--	--	1 word @ 10 inst
DOD Update	10	--	--	1 word @ 10 inst
Restore Media Record	60	1	--	10 inst for linkage 50 inst for disk access
(A) Retrieve a Related Fault Record Under Controllers Responsibility	450	6	--	1 fault file access @ 2 disk accesses - 100 inst 50 inst for pointer processing
Precedence Severity Compare New Fault Higher	90	--	--	10 conditional test @ 3 inst each for 3 faults

ALGORITHM - S1 (Continued)

DESCRIPTION - Sector - Receipt of Fault Notification Broadcast from Sectors

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Generate Discontinue Notification	210	--	--	10 inst to retrieve form 4 fields to inst @ 14 inst each 3 Faults
Modify Fault Record as Overridden	30	--	--	Modify 1 word @ 10 inst for 3 faults
Restore Fault Record	180	3	--	1 disk access @ 50 inst 10 inst for linkage for 3 Faults
More Faults? (Y: A; N)	3	--	--	Test pointer for end-of-list for 3 faults

ALGORITHM - S1 (Continued)

DESCRIPTION - Sector - Receipt of Fault Notification Broadcast from Sectors

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Broadcast Destination Determine	355	4	--	2 media file access @ 2 disk accesses each - 200 inst 100 inst for directory arb 5 inst to extract station 50 inst to determine node routing
Broadcast Output Prep	350	--	--	5 Nodes: 10 inst to affix destination 10 inst to affix source 50 inst to move
TERM	2288	17	--	

ALGORITHM - S2

DESCRIPTION - Sector - Receipt of Fault Notification Broadcast from ACOCs

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Input Handling	145	1	--	30 byte msg @ 2 inst/byte for error processing 25 inst/buffer switch 10 inst to decode msg 1 disk access for overlay @ 50 inst
Message Parsing	100	--	--	25 data bytes @ 4 inst/byte
Severity Check	25	--	--	5 severity @ 5 inst/check
Media Record Retrieval	230	2	--	2 disk accesses - 1 directory; 1 record @ 50 inst/access 5 directories @ 10 inst/dir address compute 8 character field @ 10 inst/char
Fault ID Update	30	--	--	3 words @ 10 inst/word
Reroute Flag Update	10	--	--	1 word @ 10 inst/word

ALGORITHM - S2 (Continued)

DESCRIPTION - Sector - Receipt of Fault Notification Broadcast from ACOCs

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Isolation Indicator Update	10	--	--	1 word @ 10 inst
DOD Update	10	--	--	1 word @ 10 inst
Restore Media Record	60	1	--	10 inst for linkage 50 inst for disk access
(A) Retrieve a Related Fault Record Under Controllers Responsibility	450	6	--	1 fault file access @ 2 disk accesses - 100 inst 50 inst for pointer processing
Precedence Severity Compare New Fault Higher	90	--	--	10 conditional test @ 3 inst each for 3 faults

ALGORITHM - S2 (Continued)

DESCRIPTION - Sector - Receipt of Fault Notification Broadcast from ACOCs

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Generate Discontinue Notification	210	--	--	10 inst to retrieve form 4 fields to inst @ 14 inst each 3 Faults
Modify Fault Record as Overridden	30	--	--	Modify 1 word @ 10 inst for 3 faults
Restore Fault. Record	180	3	--	1 disk access @ 50 inst 10 inst for linkage for 3 Faults
More Faults? (Y → A; N)	3	--	--	Test pointer for end-of-list for 3 faults

AD-A071 564 COMPUTER SCIENCES CORP FALLS CHURCH VA F/G 17/2
UNIFIED NETWORK/TRAFFIC TRANSMISSION MEDIA CONTROL.(U)
AUG 77 DCA100-76-C-0082
UNCLASSIFIED SBIE -AD-E100 234 NL

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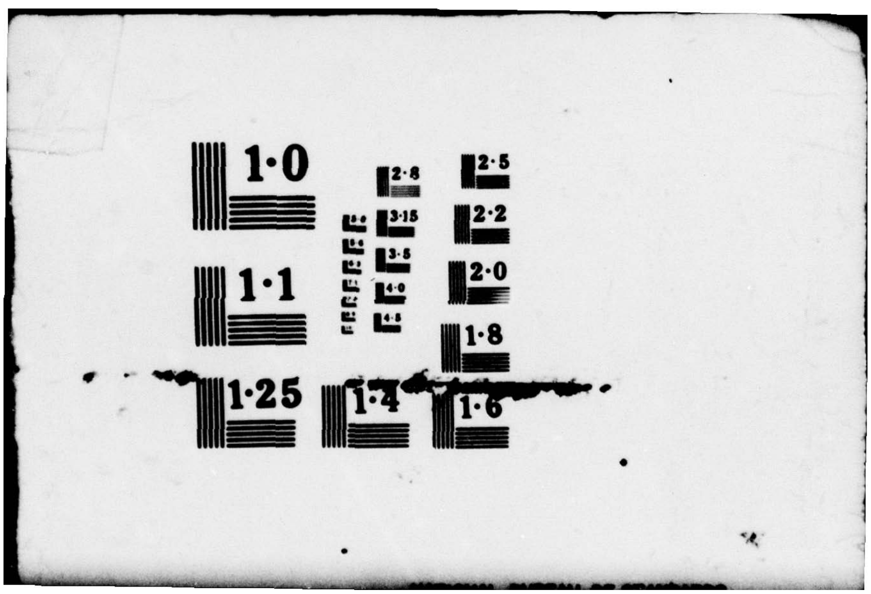
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2·8
2·5
3·15
2·2
3·5
2·0
1·1
4·0
4·5
1·8
1·25
1·4
1·6

ALGORITHM - S2 (Continued)

DESCRIPTION - Sector - Receipt of Fault Notification Broadcast from ACOCs

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Broadcast Destination Determine	355	4	--	2 media file access @ 2 disk accesses each - 200 inst 100 inst for directory arb 5 inst to extract station 50 inst to determine node routing
Broadcast Output Prep	350	--	--	5 Nodes (10 inst to affix destination 10 inst to affix source 50 inst to move
TERM	2288	17	--	

ALGORITHM - S3

DESCRIPTION - Sector - Receipt of Fault Notification Broadcast from Nodes

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Input Handling	145	1	--	30 byte msg @ 2 inst/byte for error processing 25 inst/buffer switch 10 inst to decode msg 1 disk access for overlay @ 50 inst
Message Parsing	100	--	--	25 data bytes @ 4 inst/byte
Severity Check	25	--	--	5 severities @ 5 inst/check
Media Record Retrieval	230	2	--	2 disk accesses - 1 directory; 1 record @ 50 inst/access 5 directories @ 10 inst/dir address computer 8 character field @ 10 inst/char
Fault ID Update	30	--	--	3 words @ 10 inst/word
Reroute Flag Update	10	--	--	1 word @ 10 inst/word

ALGORITHM - S3 (Continued)

DESCRIPTION - Sector - Receipt of Fault Notification Broadcast from Nodes

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Isolation Indicator Update	10	--	--	1 word @ 10 inst
DOD Update	10	--	--	1 word @ 10 inst
Restore Media Record	60	1	--	10 inst for linkage 50 inst for disk access
(A)				
Retrieve a Related Fault Record Under Controllers Responsibility	450	6	--	1 fault file access @ 2 disk accesses - 100 inst 50 inst for pointer process For 3 Faults
Precedence Severity Compare	90	--	--	10 conditional test @ 3 inst each For 3 Faults
New Fault Higher				
Generate Discontinue Notification	210	--	--	10 inst to retrieve form 4 fields to insert @ 15 inst each For 3 faults

ALGORITHM - **S3 (Continued)**

DESCRIPTION - Sector - Receipt of Fault Notification Broadcast from Nodes

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Modify Fault Record as Overridden	30	--	--	Modify 1 word @ 10 inst for 3 Faults
Restore Fault Record	180	3	--	1 disk access @ 50 inst 10 inst for linkage For 3 faults
Y A More Faults N	3	--	--	Test Pointer for End-of-List for 3 Faults
Broadcast Destination Determine	555	4	--	2 media file access @ 2 disk accesses each - 200 inst 100 inst for directory arb 5 inst to extract stations 50 inst to determine node routing 4 sectors @ 50 inst each to check destination
Broadcast Output Prep	630	--	--	4 Nodes + 4 Sectors + 4 ACOC (10 inst to affix destination 10 inst to affix source 50 inst to move
TERM	2768	17	--	

ALGORITHM - S4

DESCRIPTION - Retrieve and Display CCSD Connectivity to Sector Controller

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Input Handling	300	1	--	15 character line @ 15 inst per character 25 inst/buffer switch 1 disk access for overlay @ 50 inst
Request Parsing	70	--	--	15 characters @ 4 inst 10 inst to decode request
Connectivity Overlay Retrieval	60	1	--	10 inst for linkage 50 inst for disk access
Retrieval Type Check	100	--	--	4 levels @ 25 inst
Retrieve CCSD Record	230	2	--	1 CCSD File Access @ 2 disk accesses 8 character field @ 10 inst/char for hash 50 inst for directory arbitration
A Extract Trunk and Channel ID	192	--	--	8 bytes @ 4 inst 2/

ALGORITHM - S4 (Continued)

DESCRIPTION - Retrieve and Display CCSD Connectivity to Sector Controller

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Retrieve Trunk Record	1260	12	--	1 Trunk File Access @ 2 disk accesses 6 character field @ 10 inst for hash 50 inst for directory arb 2/
Determine Trunk Direction	150	--	--	25 inst for previous station check 2/
B				
Extract Station, Link G/SG	1800	--	--	15 bytes @ 4 inst 1/
Append Channel #	300	--	--	2 characters @ 5 inst 1/
Format Display Buffer	4500	--	--	15 character data line @ 10 inst/character 1/

ALGORITHM - S4 (Continued)

DESCRIPTION - Retrieve and Display CCSD Connectivity to Sector Controller

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
More Stations? (Y: B; N)	150	--	--	Conditional test and branch 1/
More Trunks? (Y: A; N)	150	--	--	Conditional Test and branch 1/
Dump Display Buffer	6750	--	450	30 lines @ 15 char/line 450 characters @ 15 inst/character
	18,012	16	450	
TERM				

1/ Perform for 6 Trunks each through 5 stations

2/ Perform for 6 Trunks

ALGORITHM - N1

DESCRIPTION - Node - Receipt of a Fault Notification Broadcast from the Sector

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Input Handling	145	1	--	30 byte msg @ 2 inst/byte for error processing 25 inst/buffer switch 10 inst to decode message 1 disk access for overlay @ 50 inst
Message Parsing	100	--	--	25 data bytes @ 4 inst/byte
Severity Check	25	--	--	5 severities @ 5 inst/check
Media Record Retrieval	230	2	--	2 disk accesses - 1 directory; 1 record @ 50 inst/access 5 directions @ 10 inst/dir selection processing 8 character field @ 10 inst/char for hash
Fault ID Update	30	--	--	3 words @ 10 inst/word
Reroute Flag Update	10	--	--	1 word @ 10 inst/word

ALGORITHM - N1 (Continued)

DESCRIPTION - Node - Receipt of a Fault Notification Broadcast from the Sector

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Isolation Indication Update	10	--	--	1 word @ 10 inst/word
DOD Update	10	--	--	1 word @ 10 inst
Restore Media Record (CCSD)	60	1	--	10 inst for linkage 50 inst for disk access
Extract Trunk in Connectivity	6	--	--	3 words @ 2 inst
(A) Retrieve Trunk Record	480	6	--	(2 disk access @ 50 inst each 6 char field @ 10 inst/char for hash) 1/
Test Trunk Status (Good)	15	--	--	Conditional Test 1/

ALGORITHM - N1 (Continued)

DESCRIPTION - Node - Receipt of a Fault Notification Broadcast from the Sector

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
B				
Extract Link	36	--	--	3 words @ 2 inst [2/]
Retrieve Link Record	990	9	--	(1 disk access @ 50 inst 6 char field @ 10 inst/char for hash) [2/]
Test Link Status (Good)	45	--	--	Conditional Test [2/]
Extract Station	54	--	--	3 words @ 2 inst [2/]
Retrieve Station Record	990	9	--	(1 disk access @ 50 inst 6 char field @ 10 inst/char for hash) [2/]
Test Station Status (Good)	45	--	--	Conditional Test [2/]

ALGORITHM - N1 (Continued)

DESCRIPTION - Node - Receipt of a Fault Notification Broadcast from the Sector

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Generate Notification Message for Station	100	--	--	20 character line @ 5 inst/char 2/
More Links? (Y: B; N)	45	--	--	Conditional Test 2/
More Trunks? (Y: A; N)	15	--	--	Conditional Test 1/
ATEC/ Monitor Equipped (Y)	5	--	--	Conditional Test
Generate ATEC Status Request	25	--	--	10 inst to retrieve from 3 fields to insert @ 5 inst/field
Schedule For ATEC Output	29	--	--	8 word message to move 3 inst/word 5 inst to set schedule flag

ALGORITHM - N1 (Continued)

DESCRIPTION - Node - Receipt of a Fault Notification Broadcast from the Sector

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Schedule Output Notifications	90	--	--	5 stations to notify and controller @ 15 inst/station
TERM	3490	28	--	

1/ Aggregate for 3 Trunks

2/ Aggregate for 3 Trunks and 3 Links

ALGORITHM - N2

DESCRIPTION - Node - Accept Fault Entry from Stations

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Input Handling	110	--	--	30 byte msg @ 2 inst/byte for error processing 50 inst for buffer management
Fault Data Parsing	80	--	--	8 fields @ 10 inst
Generate Fault Record	200	--	--	20 fields @ 10 inst
Schedule Detailed Processing	5	--	--	Set a Flag
TERM	395	--	--	

ALGORITHM - N3

DESCRIPTION - Node - Accept Fault Entry from AUTOVON Module

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Input Handling	125	1	--	30 byte msg @ 2 inst/byte for error processing 15 inst for buffer management 1 disk access for overlay @ 50 inst
Message Decode	5	--	--	Conditional Test
Fault Data Parsing	80	--	--	8 fields @ 10 inst
Generate Fault Record	200	--	--	20 fields @ 10 inst
Schedule Detail Processing	5	--	--	Set a Flag
TERM	415	1	--	

ALGORITHM - N4

DESCRIPTION - Node - Accept Fault Entry from AUTODIN Report Processor

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Input Handling	210	1	--	80 character msg @ 2 inst/byte for error processing 1 disk access for overlay @ 50 inst
Fault Data Parsing	65	--	--	13 fields @ 5 inst
Generate Fault Record	200	--	--	20 fields @ 10 inst
Schedule Output Processing	5	--	--	Set a flag
TERM	480	1	--	

ALGORITHM - N5

DESCRIPTION - Node - Accept Fault Entry from ATEC

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Input Handling	125	1	--	30 byte msg @ 2 Inst/Byte for error processing
Message Decode	5	--	--	Conditional Test
Fault Data Parsing	80	--	--	8 fields @ 10 inst
Generate Fault Record	200	--	--	20 fields @ 10 inst
Schedule Detailed Processing	5	--	--	Set A Flag
TERM	415	1	--	

ALGORITHM - N6

DESCRIPTION - Node - Perform Detailed Fault Entry Processing

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Security Check	25	--	--	5 severities @ 5 inst/check
Media Record Retrieval	230	2	--	2 disk access - 1 directory; 1 record 50 inst/access 5 directories @ 10 inst/dir selection processing 8 character field @ 10 inst/char for hash
Extract Trunk in Connectivity	6	--	--	3 words @ 2 inst
A				
Retrieve Trunk Record	480	6	--	(2 disk access @ 50 inst each 6 char field @ 10 inst/char for hash) 1/
Test Trunk Status Good	15	--	--	Conditional Test 1/

ALGORITHM - N6 (Continued)

DESCRIPTION - Node - Perform Detailed Fault Entry Processing

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
(B)				
Extract Link	36	--	--	3 words @ 2 inst 2/
Retrieve Link Record	990	9	--	(1 disk access @ 50 inst 6 char field @ 10 inst/char for hash) 2/
Test Link Status (Good)	45	--	--	Conditional Test 2/
Extract Station	54	--	--	3 words @ 2 inst 2/
Retrieve Station Record	990	9	--	(1 disk access @ 50 inst 6 character field @ 10 inst/char for hash) 2/
Test Station Status (Good)	45	--	--	Conditional Test 2/

ALGORITHM - N6 (Continued)

DESCRIPTION - Node - Perform Detailed Fault Entry Processing

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Generate Notification Msg for Station	100	--	--	20 char line @ 5 inst/char 2/
More Links? (Y: B; N: continue)	45	--	--	Conditional Test 2/
More Trunks? (Y: A; N: continue)	15	--	--	Conditional Test 1/
ATEC/ Monitor Equipped (Y: continue)	5	--	--	Conditional Test
Generate ATEC Status Request	25	--	--	10 inst to retrieve form 3 fields to insert @ 5 inst/field
Schedule for ATEC Output	29	--	--	8 word msg @ 3 inst/word to move 5 inst to set flag

ALGORITHM - N6 (Continued)

DESCRIPTION - Node - Perform Detailed Fault Entry Processing

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Fault ID Update	30	--	--	3 words @ 10 inst/word
Reroute Flag Update	10	--	--	1 word @ 10 inst
Isolation Indication Update	10	--	--	1 word @ 10 inst
DOD Update	10	--	--	1 word @ 10 inst
Restore CCSD Record	60	1	--	10 inst for linkage 50 inst for disk access
Schedule Output Notifications	75	--	--	4 stations and controller to notify @ 15 inst/each
TERM	3330	27	--	

ALGORITHM - N7

DESCRIPTION - *Retrieve and Display CCSD Connectivity to Node Controller*

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Input Handling	300	1	--	15 character line @ 15 inst per character 25 inst/buffer switch 1 disk access for overlay @ 50 inst
Request Parsing	70	--	--	15 characters @ 4 inst 10 inst to decode request
Connectivity Overlay Retrieval	60	1	--	10 inst for linkage 50 inst for disk access
Retrieval Type Check	100	--	--	4 levels @ 25 inst
Retrieve CCSD Record	230	2	--	1 CCSD File Access @ 2 disk accesses 8 character field @ 10 inst/char for hash 50 inst for directory arbitration
A				
Extract Trunk and Channel ID	192	--	--	8 bytes @ 4 inst 2/

ALGORITHM - N7 (Continued)

DESCRIPTION - Retrieve and Display CCSD Connectivity to Node Controller

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
Retrieve Trunk Record	1260	12	--	(1 Trunk File Access @ 2 disk accesses 6 character field @ 10 inst for hash 50 inst for directory arb) 2/
Determine Trunk Direction	150	--	--	25 inst for previous station check 2/
(B)				
Extract Station, Link G/SG	1800	--	--	15 bytes @ 4 inst 1/
Append Channel #	300	--	--	2 characters @ 5 inst 1/
Format Display Buffer	4500	--	--	15 character data line @ 10 inst/character 1/

ALGORITHM - N7 (Continued)

DESCRIPTION - Retrieve and Display CCSD Connectivity to Node Controller

Processing	No. Inst.	No. Disk Access	No. Char Displayed	Rationale
More Stations? (Y: B; N)	150	--	--	Conditional test and branch 1/
More Trunks? (Y: A; N)	150	--	--	Conditional Test and branch 1/
Dump Display Buffer	6750	--	450	30 lines @ 15 char/line 450 characters @ 15 inst/character
	18,012	16	450	
TERM				

1/ Perform for 6 Trunks each through 5 stations

2/ Perform for 6 Trunks